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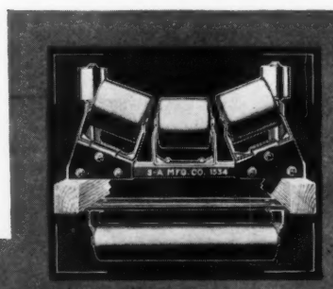

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The Ethics of Mining

THE WORD "ETHICS" is derived from a Greek word, as the word "morals" is derived from the Latin. Etymologically they both mean the same —customs, practice, habits. As is invariably the case, all these words have come to have different significance. Nevertheless, ethics is still the code of action which has been established by the test of much application, as the best to promote the welfare of society as a whole; a code beyond which one cannot go without injuring someone else. It is an analysis and inventory of the aphorism that a man's liberty finds its limits when it infringes on the liberty of his neighbor.

Thus, each group must formulate its own ethical code, although, indeed, there are general codes for all humanity, and it has been held that the Ten Commandments, or at least the Golden Rule, covers all cases. Nevertheless, there arises the question of ethics among mining engineers, not fully solved; of the ethics of business publications, woefully transgressed by some of our contemporaries in mining publication; and of the ethics of mine promotion, more honored, possibly, in the breach than in the observance.

There is an unwritten code in the U. S. Geological Survey that a member of the Survey shall not be actively interested in mining, nor do private geological work, even in his vacation, within the United States. This has long been observed; and other Government departments are as scrupulous. The geologist, however, may go to Mexico or Canada, for private work, in his vacation or on leave of absence without pay. The observance of this has been largely responsible for the fair name of the Geological Survey.

A consulting mining engineer is bound to safeguard from competing interests the information which he gathers from his employers. If the welfare of the state or the public is at stake, or his client turns out to be conducting a campaign menacing unfairly either the public or private interests, then, of course, he can no longer consent to be even a silent partner in wrongdoing.

A mining journal may not properly allow its pages to be bought or influenced by any interest whatever except that of the mass of its subscribers. It must not work as a partisan, paid or unpaid, with any financial group. It will not permit itself to be browbeaten. It will not blackmail.

A mining promoter should not state anything but the bold and naked truth, in endeavoring to raise funds. He must base his campaign on the cold-blooded opinion of responsible mining engineers, not on the testimony of druggists and politicians, nor must he paint glowing pictures which in his heart he acknowledges as being drawn to attract the "come-ons." Unless he walk this honest and straightforward path, he is outside the pale of the ethics of good promoters.

These are, in a desultory way, some of the problems of ethics, pertaining to different phases of the mining profession. After all, it all comes down to fundamental and universal qualities—honesty, honor, fairness, and generosity. With these qualities cultivated and encouraged, it is not so necessary to draw up codes, for problems bring their own solution. For a man may cleverly conform to the law, studying so as to adapt it to its desires; he may conform, according to all argument, to any code of ethics which can be devised, and still be crooked.

Promised Co-operation From the Non-Metallic Mineral Industries

MUCH INTEREST has been aroused by our editorial of May 6 wherein we discussed, in general, the apparent failure of the non-metallic mineral industries to keep abreast of the other branches of the mining industry in the utilization of improved methods and machinery and in the adoption of progressive economic policies; and, in particular, a report of the Bureau of Mines on conditions in one such industry, together with a criticism of the report by the manager of an important company producing and grinding the mineral concerned. For one thing, a number of men prominent in non-metallic mineral operations have declared their conviction that inefficient technical methods, obsolete machinery, and old-fashioned policies are too prevalent.

One subscriber who is developing a graphite deposit relates his experience in buying mill machinery in Philadelphia. The dealer has machines of various types, each of which has proved successful at some graphite mills and unsuccessful at others; but as to precise differences in conditions that accounted for the divergence in results, he has no information. His representatives had never been welcomed at the mills, and the operators who had found certain equipment unsatisfactory had declined to give their opinion as to the cause of the failure, but had come to Philadelphia and selected some other machine with which to experiment.

This instance may not be typical of the policies of graphite producers, but it does indicate an attitude on the part of some of them that is harmful—harmful to the graphite industry itself, not to anyone else. There may be significance in the fact that little publicity has been given to the technique of mining and "concentrating" graphite. It is disagreeable for any one to find that he has made a mistake in selecting machinery; but to refuse to give others in the industry the benefit of knowing why the machinery did not work seems to us to be short sighted. It is fair to assume that the engineers in charge of these operations collected accurate data on the performance of the different machines. Suppose that each of them had published his results, together with a description of the particular ore with

which he had to deal and the particular product that he desired to make. The probability is strong that every one of them would have learned something that he did not know. If the domestic graphite industry is ever to revive, the most efficient and economical methods will necessarily be used, and by the development of these methods every one in the industry will benefit.

A producer of high-grade feldspar confesses that the criticism applies to his industry to a regrettable extent; he is impressed with the soundness of our observations and declares for a more enlightened policy among all those interested in the production and grinding of feldspar.

An engineer for the Bureau of Mines explains that the inquiry on which the report was based was undertaken at the solicitation of certain consumers in an effort to discover why they were unable to obtain a satisfactory material, rather than for the purpose of analyzing every phase of the industry. This accounts for the fact that no mention was made of any commendable practices. He also points out that before being issued to the public the report was subjected to careful scrutiny by a number of competent men, whose suggested amendments were incorporated in the final draft, so that the result represented more than the investigation of one man "for thirty days," as we remarked in the editorial. At the same time, it is true that an investigator with broad experience in work of a similar character frequently can, in a brief study, detect faulty methods that have been overlooked for years by the man who is in direct charge. The reason is that the manager's viewpoint is too close to his work. Our argument was that he should at least give careful consideration to the suggestions of the outsider.

Several letters have been received from engineers who commend our attitude and volunteer to give us accurate and reliable information on sundry non-metallic mineral operations. These were particularly gratifying. Naturally, if we are to be of service to the industries involved we must draw material from men who are engaged in them. We are anxious to help in the solution of the problems—technical, financial, and economic—that confront the producers and refiners of non-metallic minerals. We believe that honest and open publicity will help all concerned, and we are prepared to do our part by supplying that publicity. But we must have co-operation if our efforts are to be successful. For that reason it is particularly satisfactory to have the assurance of a desire on the part of our friends in the field to open to us the sources of first-hand information.

Diamonds in Arkansas

RICH as North America is in valuable minerals, we do not associate the idea of its mineral wealth with diamonds. Diamonds come from Africa, in the popular mind; and, indeed, for all practical purposes, that is where gem diamonds come from, although the dark diamonds (or bort) used for cutting purposes in diamond drills come from Brazil; and there is also a certain amount of gem stones in parts of South America.

In most instances gem diamonds occur in a special very basic type of igneous rock—an olivine rock (or peridotite), intrusive, ordinarily, in pipe-like forms. This igneous rock has been profoundly altered to a clayey condition; and it is in this clay that the African diamonds occur.

In Arkansas, however, there is a diamond-bearing rock that conforms to the usual rule in that it is a peridotite, intrusive as a neck or pipe in sedimentary rocks. The age of the intrusion is probably post-Cretaceous. It is in this rock that the diamonds occur. They have long been known, and many diamonds have been produced, but practicable exploitation has proved to be a difficult problem.

The central motif of romance, adventure, murder, and burglary; the symbol of wealth and vanity; the favorite figure of the poets—these little grains of crystallized carbon (they differ from coal, wood, and the fizz of soda water, chiefly in the crystallinity), are likewise still somewhat of a mystery to geologists. They are found—though they are small—in meteorites, and so are shot to us from other and unknown world catastrophes.

Diamonds have been found in the glacial drift at many places throughout our northern states. The glacial current was, of course, from the north; and therefore, students of this phenomenon conclude that there was a source, perhaps, for all these diamonds, "somewhere north." Will it ever be found? Its erratic representatives indicate possibly an important primary source. Does it underlie some muskeg in the Hudson Bay country, or is it forever safeguarded by the waters of the Northern Ocean?

Capital and Government

EUROPEAN matters seem to have approached a more satisfactory turn by Germany practically consenting to put her financial system under the supervision of the Allies, a concession which betokens good faith, and was so received by France as well as England.

Our advices from Germany are that the bulk of the people are loyal to the present German Republic, and to the general plan of republican form of government. Admittedly, however, this government, with a former saddle-maker as president, has a most difficult course to steer, considering the bankrupt condition of its fiscal system, and with the monarchists on the one side and the red communists on the other. By and large, the present German government should have our support, and will naturally have it if it acts in good faith.

Capital and labor are as great problems in Germany as elsewhere. In Germany the artisan and the white-collar man have completely reversed pre-war conditions; it is the former that has the luxuries, while the latter is driven to unheard-of economies. The wages of the former rise with the decline of value of the currency; but the government employee and all the great class of similar salaried office workers view a continually widening breach between income and outgo. The "rentiers," who live only on income from investments, are, of course, ruined. We have a marked similar tendency in this country, but pale by comparison. The workman who before the war received $2 a day, now receives $6. The carpenter receives $10 where he received $3; while the clerk who received $1,500 a year now receives $2,000—if he is lucky.

Thus, labor is relatively prosperous in Germany. Capital, also, according to our European correspondent, has found a way to flourish. Manufacturers can produce goods in Germany at low cost, and they can sell abroad at high profit; and these profits they invest abroad, so that they slip through the net of German

taxes like water through a sieve, and evade the plans of the government for reparations. In other words, capital and the government are not working together; to speak colloquially, the former is double-crossing the latter.

We might take the situation as a text for a sermon on the necessity of co-operation between capital and government, as well as between labor and government—in fact, the necessity for harmony among all three. Antagonism between capital and government spells economic disaster. It is the great endeavor of Secretary Hoover to accomplish co-operation instead of the traditional silly and ruinous antagonism. To force capital to be antagonistic is to force it to be disloyal; to foster an element of economic treason in a form of government which has come to be essentially an economic union.

Substitutes for Gasoline

THE MINING INDUSTRY shares with other industries an anxiety in regard to future supplies of motor spirit, especially when operations are being conducted at great distances from oil refineries. It is interesting to note, however, that during recent years the high cost of gasoline in isolated districts has acted as a spur to initiative in the discovery and the development of a cheaper and equally efficient substitute.

Much attention has been paid to the alcohol that can be produced from various classes of vegetal matter. It has been found, however, that the substitute can be made only at a prohibitive cost unless the new industry operates in conjunction with other industries. To make the venture a success, one of two courses must be adopted: the alcohol factory must be able to produce cheaply a salable byproduct, or the alcohol itself must be manufactured as a byproduct of another industry. In South America, for instance, considerable success has resulted from the use of alcohol as a fuel in internal-combustion engines.

Near Pernambuco, in Brazil, a large sugar mill is producing a spirit from the discarded cane, and at less than half the cost of gasoline. Excellent results are being obtained by the use of the new fuel in motor vehicles, but some trouble was caused at first by the rusting of certain parts of the engine, a disadvantage that has since been overcome by the addition of about 5 per cent of gasoline to the sugar-cane spirit. In another district of Brazil, alcohol is produced as a byproduct from a wood distillation plant, operated by the St. John Del Rey mining company. The efficiency of the spirit, which is used in the motors without the addition of any corrective, is not so high as that of gasoline, but according to reports, no damage to motor parts has resulted.

A considerable amount of success has resulted in South Africa by the use of a combination of alcohol and acetylene. Cattle food is obtained as a byproduct. The addition of acetylene is considered essential, for without it the local wood spirit possesses disadvantages that make it only partly efficient as a motor fuel. Unfortunately, however, the amount of acetylene gas that such spirit can absorb is small—only about six times its volume. However, in distilling the volatile products from wood another byproduct is made—acetate of lime, from which acetone is derived—and the process therefore has large commercial possibilities.

Germany imported large quantities of acetate of lime from the United States before the war. Among other uses of acetone is in the preparation of artificial rubber, which Germany needed so badly when her overseas supplies were cut off. Acetone was then obtained from the acetate of lime that resulted from the distillation of wood. Later, when increased supplies of rubber were needed, another method had to be adopted; and potatoes were allowed to ferment after a bacillus known as *B. acetoethylicum* had been added. The resultant decomposition produced acetone and alcohol, the former being successfully utilized in a process for making artificial rubber.

It has been found that acetone absorbs about twenty-five times its volume of acetylene, so the motor-spirit problem appears to have been solved by the suggestion that sufficient acetone be added to the wood alcohol. It has been found that 80 per cent of wood alcohol and 20 per cent of acetone is an excellent mixture in which sufficient acetylene may be absorbed to produce an efficient motor spirit. A number of natural products in South Africa are being tested as possible sources of acetone, waste corn cobs being favored on account of the quantity available; for maize, as corn is called there, is the staple food for the Kafirs. Tests have also been made in the United States, the results showing that 100 lb. of cobs can be made to produce about 2.7 lb. of acetone and 6.8 lb. of alcohol.

Experiments are being carried out in several other countries in an effort to obtain alcohol from Jerusalem artichokes. Results so far have been successful, and intensive cultivation may follow, all the more likely because it has been proved that the discarded stems can be manufactured into pulp for the making of certain grades of paper.

In Cuba there is strong indication that gasoline will soon be replaced entirely by wood alcohol, obtained, as in Brazil, from the waste product of the sugar mills. The average cost of gasoline in Havana is about 50c. per gallon. Alcohol costs about 35c. per gallon. Drivers of automobiles for hire who are using the substitute have found that they can reduce fares by one-third, and the price charged still permits a fair margin of profit after operating expenses are deducted.

The cost of gasoline in India has been so high that a factory has been established in Hyderabad for the production of alcohol from the flowers of the mahwa trees. The industry has already attained significant proportions, the daily output having reached 10,000 gallons. In little-known Papua, or New Guinea, there is an immense area of land that is covered with the nipa palm. Preliminary investigations and tests have shown that the tree will yield alcohol in sufficient quantity to justify the raising of capital for a plant that is to cost over $1,000,000, insuring employment for 1,500 natives and 60 whites. It is proposed to produce 3,000,000 gallons of motor spirit per year, as well as 500 tons of paper as a byproduct. In the Philippines the sap from the nipa palm tree forms the source of 90 per cent of the alcohol produced there. It costs under 10c. per gallon.

Necessity is the mother of invention; and invention in the present instance seems likely to discover a cheap source of power for motor vehicles and stationary engines that, unlike natural oil, is inexhaustible; for it is the product of vegetal growth, the continuance of which can be insured by scientific cultivation and control.

The Forecasting of Earthquakes

BY T. A. RICKARD

AN APPROPRIATION of $15,000 was made recently by Congress for the use of the U. S. Coast and Geodetic Survey, for the special purpose of repeating and extending the triangulation of the Pacific Coast region. This was done in response to a public demand, voiced by the Commonwealth Club of San Francisco and the Local Section of the American Institute of Mining and Metallurgical Engineers, and in recognition of public interest in the creep of the earth's crust as observed and recorded in California. We who live on this coast have a more than academic interest in movements of the earth's crust; we have witnessed the effects of terrestrial unrest; but most of us are unfamiliar with the remarkable phenomenon of surficial creep as proved by the change in latitude of a given locality. Astronomers long ago predicated a variation of the earth's axis in consequence of the seasonal differences in the weight of snow and ice deposited over the land areas of the northern hemisphere and the periodic variation in the pressure of the atmosphere. In 1880 Küstner discovered that the latitude of a point on the earth's surface actually does vary, owing to the 'wobbling' of the Pole. His survey led to systematic observations of fixed stars from five international stations on the same parallel of latitude. One of these points of observation was established at Ukiah, in California.

Investigation has shown definitely that in 17 years, from 1900 to 1917, the latitude of Ukiah has been increased by a northward trend equivalent to 28 centimeters per annum. Since then the direction of the trend has been reversed. Professor A. C. Lawson, of the University of California, has given special study to the subject. He found evidence in the record to show that besides the variation of latitude due to the vacillation of the Pole there is a movement due to the creep of the earth surface. From him I learn that Mount Tamalpais, overlooking the Bay of San Francisco, moved 3.04 metres northward between 1854 and 1900 by reason of this strain-creep and then 1.97 metres southeastward by rebound in 1906, the year of the great Californian earthquake. It will be seen at once how difficult it is to measure the displacement caused by an earthquake when the datum-points themselves are shifting appreciably. The whole system of triangulation has been vitiated thereby. Professor Lawson draws the conclusion that the local movement of the earth's crust is not confined to the sudden disturbance rendered evident by an earthquake; on the contrary, the energy let loose, for example, on April 6, 1906, accumulates as an elastic compression, and the sudden release of it, when the limit of strain is reached, is expressed by the break or rift that constitutes the line of the faulting. Thus we have the theory of elastic rebound, which the Professor noncommittally calls "a good working hypothesis".

The geodetic surveys prove that there is a creep of the earth's crust; the inference being that the region affected is subject to an elastic strain, which occasionally reaches the limit, whereupon a slip occurs, accompanied by the vibrations we call an earthquake. However, even if the theory of elastic rebound were to be established, it would not enable the scientist to give the public the date of an impending disaster. The factors detrimental to accurate prediction are numerous; the difficulty of positive measurement of movement is only one of them. By use of the data obtained at points of observation near San Francisco at this time one prediction would give an interval of 58 years between the last big earthquake and the next one; another would give 35 years as the time when the strain in this region would exceed the elasticity of the rocks and cause another big slip; a third prediction would place the estimate at 46 years. These three estimates might be averaged, giving the figure 45, but to do so would be unscientific, because the errors in the datum-line and the local variation in strain-creep, for example, do not permit a confident forecast. The final test of a scientific theory is that of prediction. Professor Lawson exhibits the true spirit of science in declining to apply a theory to practical affairs until it has been demonstrated to be true. It is more than likely that any attempt by geologists to forecast an earthquake would do more harm than good, apart from the unsafeness of their dictum, because the anxiety caused by the anticipation of the event might do more harm than the shock itself.

To the miner the subject has a special interest because he is familiar with the evidences of crustal slippage in the shape of faults, which break the continuity of his ore-channels and otherwise complicate the structure of the rocks in which he delves. He is impressed with the enormous extent of the dislocations to be seen in deep natural sections of the earth's crust, and he compares such breaks—measurable in miles—with the geologically small rift that made all the trouble in San Francisco sixteen years ago. If the bigness of the slip be proportioned to the elasticity and strength of the rocks, then there seems no reason to suppose that the big faults are peculiar to a remote geologic past; on the contrary, we are driven to the conclusion that a big fault—of 10,000 feet, for example—represents the sum of many small movements taking place during a long period of time. The San Francisco earthquake represented the movement of a block of rock 270 miles long, 50 to 100 miles wide, and 20 miles deep. The movement of this block was that of a piece of brittle crust over a viscous mass; it was due probably to the shifting of weight caused by erosion, thereby creating an unstable condition, which had to be rectified. This is the doctrine of isostasy. In 1906 in California local strain was relieved by a movement that was expressed by a maximum horizontal shift of 21 feet and a maximum vertical displacement of 1½ to 2 feet. The vertical component was small, compared, for example, with that of the Inyo earthquake of 1872, which followed the line of the great fault of the Sierra Nevada. That earthquake was accompanied by a vertical movement of 20 feet; and it would have been terribly destructive if it had passed through any large centre of population. The calamitous effects of the earthquake of 1906 in San Francisco were due chiefly to the complexity of our material civilization, for the damage was done by the conflagration, caused by the fracture of gas-pipes and the short-circuiting of electric wires, which started numberless fires at a moment when the water-mains had been ruptured by the movement of the surface.

DISCUSSION

How Should Depletion and Depreciation Be Charged?

Advantages of Uniformity, Clearness, and Completeness in Publishing Statements of Mining Companies, With an Example of Cost Computation

THE EDITOR:

Sir—In your issue of May 5 there appears an article with the above heading. This article brings out the lack of uniformity in determining costs, especially by the copper mines, and shows that even in the case of one mine certain items are included in the published cost per pound for one year and omitted in another year.

In this article the statement is made that the amount paid as Federal income and profit taxes should be included in the production cost, but as depreciation and depletion are bookkeeping entries, there might be some doubt as to whether or not such charges should be included in the published cost.

There is no doubt as to the great need for standardization in the recording and reporting of costs, as well as the need for a standard form of profit-and-loss statement and balance sheet. The stockholders of the numerous mining companies and the investing public are beginning to demand greater uniformity and clearness in the published reports showing costs, statements of earnings, and the condition of the business, and it is only a question of time when the published costs and general accounting statements of the larger mining companies will be standardized the same as has been done by the railroads, the public utilities, and others.

However, answering the question, What justification is there for applying depletion and depreciation as a production cost instead of the income and excess profits taxes? I will say that depletion and depreciation should always be included in the production cost; though there is some doubt whether or not the Federal income taxes should be included in the production cost.

As to the depreciation and depletion charges: There is no reason for the apparent misunderstanding of the depletion charge. The depletion charge in mining is the same as the "cost of goods sold" in merchandising, or "cost of raw materials used" in manufacturing. In merchandising, the "cost of goods sold" can be accurately ascertained as a rule, but there is some difficulty in determining the exact depletion charge in mining, although in the case of a proven mine of large tonnage it is much simpler than some believe.

As the Federal tax law allows the depletion charge against gross income to be based on the value as of March 1, 1913, there is added a further complication in the determination of depletion as a cost when the value as of March 1, 1913, is in excess of investment value. However, when this is true, the depletion charge should be divided into "depletion of investment" and "depletion of appreciation," and only the depletion of investment charged as a cost.

Charges against production for depletion of investment in mine property and for depreciation of investment in equipment are in the nature of deferred charges, as the expenditures for these investments were made in prior years, or probably prior to the beginning of production. Of course, the yearly depletion and depreciation charges may be more or less an estimate, but when based on cost and the amount of exhaustion, represent an actual expenditure as much as the current year's disbursements for production labor and supplies. Therefore, the charges for depletion and depreciation of mine investment should be included in the cost of production without any more doubt than there would be about including the "cost of raw materials used" in determining the cost of a manufactured article.

As to the charge for Federal income and profits taxes: There is no substantial reason for including such charge in the production cost. The Federal taxes are a profit-and-loss charge and not a production charge, and are determined by the amount of taxable income and the tax rates in effect. The taxable income will fluctuate principally according to general business conditions. The men in direct charge of production are not interested in the amount of Federal taxes, which may be influenced as much by the amount of outside investments as by any increase or decrease that may occur in efficiency or production.

As a suggestion, I offer the following statement of cost:

	Cents per Pound
Total operating cost	10.00
Depreciation and depletion of operating investment	1.50
Total production cost	11.50
Operating production credits	1.00
Net production cost	10.50
Net investment credits (or charges)	.25
	10.25
Federal taxes	.25
Total profit and loss cost	10.50

The manager and those under him are interested in the operating expense and credits that make up the net production cost. The directors and stockholders, in addition to their interest in the net production cost as it compares to the average selling price, are also intensely interested in what is the net investment return per pound of produced metal, what the amount of Federal taxes, and what may be expected to be the net profit-and-loss cost per pound.

At the present time there is certainly a lively interest in costs and desire for uniformity, clearness, and completeness in published statements. Investors, the public, and the law-making bodies are beginning to find out that statistics compiled in the past are more or less worthless, due to lack of uniformity and completeness in the published facts of industrial concerns. Therefore, the Government has now recognized the value of trade associations organized for the purpose of obtaining co-operation and uniformity in production and cost data.

Bisbee, Ariz. T. O. MCGRATH.

Sulphatizing Roasting of Copper Ores

The article "Sulphatizing Roasting of Semi-oxidized Copper Ores," by Percy R. Middleton, published in the *Engineering and Mining Journal-Press* of April 15, 1922, was exceedingly interesting. As somewhat similar work was done under my supervision some years ago on a full-sized unit scale, I think the results obtained might also be of interest in this connection.

At the Panuco mine, belonging to the Continental Mining Co., and situated about forty miles east of Monclova, Coahuila, Mexico, on the old Mexican International R.R., is a copper deposit consisting of a chimney of ore about 200 ft. in diameter in a syenite country rock. The inside of the chimney or cylinder is entirely filled with brecciated vein material consisting of mica, quartz, feldspar, and pyrites, coarsely crystallized, and copper principally in the form of bornite, with some chalcopyrite, a small amount of oxides, and also copper sulphate where recent oxidation has taken place.

The ore averages 3 per cent copper, and approximately one-third of the copper content is copper sulphate soluble in water. The formation of the copper sulphate has taken place since the mine was opened up by numerous workings, where high-grade pockets and bunches of ore were extracted by "buscones" in the earlier years. The oxidation was started by a fire which burned the old timbers of the mine, and oxidation is still continuing.

An average analysis of the ore gives 15 per cent iron, 13 per cent sulphur, and 55 per cent insoluble, but it varies widely from this average in different parts of the mine.

After numerous experiments and investigations to work out a method of treating the ore at the mine, it was decided to put in a Wedge mechanical furnace for roasting the ore to produce sulphate of copper and then leach the calcine with water and deposit the dissolved copper on scrap iron. One furnace was erected, with the necessary crushing plant and leaching plant, and an absorption tower was added to catch as much sulphuric acid as possible from the roasting gases, in order to aid in the leaching. The furnace was 20 ft. in diameter, with five hearths, muffle fired on the four upper hearths, and used Mexican oil for fuel.

The furnace was in operation from February, 1912, to May, 1913, and was then closed down on account of the revolution. Unfortunately, the detailed records of the work done were destroyed by the revolutionists, as the mine had to be abandoned on short notice and the books and records could not be removed to a place of safety. As a consequence, the information given here is largely from memory.

The upper four hearths of the furnace were equipped with Bristol pyrometers, so as to be able to control the roasting temperatures. The furnace was down-drafted, the gases passing through a small dust flue, then through a brick absorption tower packed with tile, and finally through a lead fan and out of the stack. It is my understanding that the down-draft feature is patented by the Wedge Mechanical Furnace Co.

It was found impracticable, with the down-draft, to heat the ore sufficiently from the muffles to get the roasting started on the upper hearths, so three direct-fired oil burners were installed on the top hearth. With these in use it was found unnecessary, except on occasions when the sulphur content of the ore was unusually low, to fire the burners in the muffles. Whenever the sulphur content of the ore became higher than 10 to 12 per cent, it was found that the temperatures became too high, with a resultant poor sulphatization of the copper. However, we did find a good use for the muffles during high temperatures, as under those conditions we pulled out brick in the outer walls of the muffle, letting in cold air and thus reducing the temperature of the ore on those hearths. The temperatures which were found to give the best results were about as follows:

First hearth	500 degrees Fahrenheit
Second hearth	700 degrees Fahrenheit
Third hearth	900 degrees Fahrenheit
Fourth hearth	1,050 degrees Fahrenheit
Fifth hearth	Cooling

About 6,000 metric tons of ore was treated altogether. With ore running less than 12 per cent sulphur the furnace would treat thirty metric tons of ore per twenty-four hours, with an average extraction of 85 per cent of the copper in a solution from the absorption tower, and 80 per cent water-soluble copper. The solution from the absorption tower ran about six grams per liter in H_2SO_4 content.

It was found that the strength of the solution in sulphuric acid did not have much effect on the extraction. What was needed was a sufficient quantity of H_2SO_4 in weak solution, and we did not obtain the needed quantity from the absorption tower. The extraction with the tower solution on the best days reached 95 per cent, and on one run of three successive days on which I happen to have the record the extraction was 91 per cent.

The furnace was attended by Mexican laborers picked as the most intelligent from the labor gang on construction work, and it was not difficult to teach them how to control the temperatures with the oil burners.

The down-drafting of the furnace causes the SO_2 gases to pass over the hot iron oxides in the lower hearths, and no doubt some catalytic action takes place, as the SO_3 content of the escaping gases is much higher when the gases are down-drafted than when they are up-drafted.

An ordinary absorption tower, using water as a scrubber, will recover only a small proportion of the SO_3 in the form of a weak sulphuric-acid solution. There is, however, little doubt that a Cottrell plant would recover nearly all the SO_3 from the gases after they had passed the scrubber tower, and thus had been cooled and moistened.

The higher percentage of SO_3 in the down-drafted gases no doubt aids the sulphatization of the copper, especially if some of the sulphate already formed is broken up by too high a temperature in the upper hearths, in which case the oxide of copper formed is at least partly resulphatized on the lower and cooler hearths where it comes in contact with the SO_3 in the gases.

The ore after roasting had a high rate of percolation in the leaching tanks, although it had an extremely slow rate when raw.

The cementation was carried on intermittently in three redwood tanks, 20 ft. in diameter and 4 ft. deep, heating the solutions with steam so as to cause a circulation of the solution in the tanks and hasten the precipitation of the copper on the iron by both the heat and circulation. The consumption of scrap iron was 1.2 lb. of iron per pound of copper, and by the method used practically complete precipitation of the copper in the solutions was obtained. The cement copper ran 57 per cent copper.

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Sulphur Resources of Chile

Deposits of the Chilean Cordillera Form an Important Part of the World's Known Reserve of the Mineral—Industry Still in Its Infancy—Production in 1918 Totaled 19,557 Metric Tons—Operations Require Systematizing

BY HERBERT G. OFFICER

THE SULPHUR DEPOSITS of Chile are little known. They are on the volcanic peaks of the Andes, and the high altitudes and remoteness from railways have retarded development. Production is comparatively small; the greater part goes to supply domestic demands. Only in recent years has the country exported any sulphur, and then only to neighboring South American republics. The export business is capable of expansion.

There is little danger of competition to the Gulf Coast producers of Louisiana and Texas, so far as their markets in the Eastern States are concerned. However, if the Chilean deposits were properly financed, equipped, and managed, the product might successfully compete with the Gulf Coast sulphur in the markets on the Pacific Coast of the United States. The principal present interest in the Chilean deposits lies in the immense reserves and the possibility of their being some day called upon to supply the markets of the world.

TABLE 1. STATISTICS ON THE SULPHUR INDUSTRY IN CHILE
PRODUCTION, IMPORTATION, EXPORTATION, AND CONSUMPTION
(Metric Tons of 2,204 Pounds)

Year	Production	Imports	Exports	Consumption
1909	4,507	193	None	4,700
1910	3,822	1,400	None	5,222
1911	4,451	4,013	None	8,464
1912	4,431	4,451	None	8,882
1913	6,647	1,961	None	8,608
1914	10,008	526	None	10,534
1915	9,769	711	None	10,480
1916	14,879	1,080	None	15,959
1917	18,942	47	3,555	15,434
1918	19,557	None	6,406	13,151

The sudden increase in consumption in 1916 was due to the purchase by the Chile Exploration Co. of from 4,000 to 5,000 tons per year for the manufacture of acid for use in leaching copper ores at Chuquicamata.

TABLE 2. EXPORTS OF SULPHUR FROM CHILE

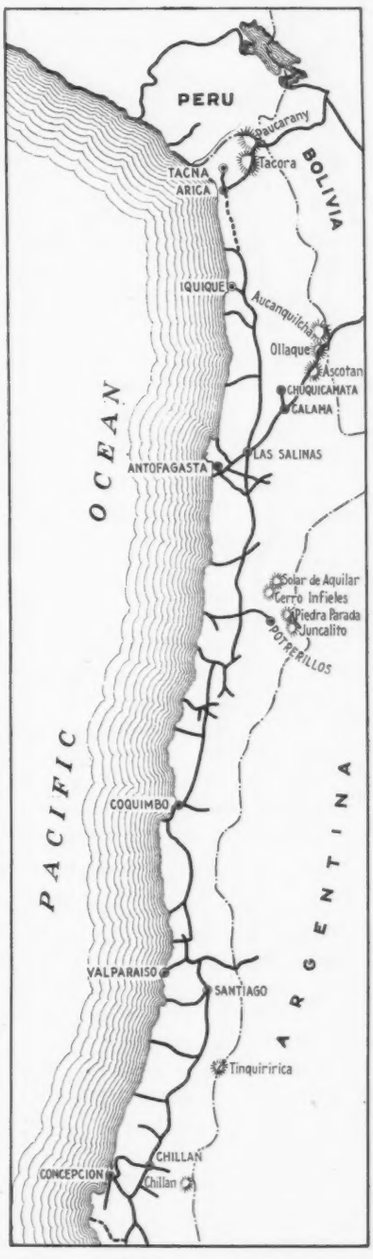
	1917		1918	
Country	Metric Tons	Value in U. S. Dollars	Metric Tons	Value in U. S. Dollars
Argentina	1,976	$106,720	3,028	$241,500
Bolivia	41	2,224	51	3,670
Brazil	1,227	66,276	2,873	157,300
Uruguay	248	13,371	260	23,000
Totals	3,555	$191,968	6,406	$446,270
Average value per metric ton placed in port		$54.00		$69.60

TABLE 3. STATISTICS OF PRINCIPAL PRODUCERS OF SULPHUR IN 1918

Producer	District	Number of Men Employed	Average Wage, U.S. Equivalent	Tons of Fuel (Yareta) Used	Metric Tons of Sulphur Produced
E. Dondero	Tacora	50	$0.70	2,000	2,000
J. Carrasco	Ollague	80	1.70	4,500	6,200
Espada Bros.	Tacora	160	0.80	3,000	5,200
Muecke & Co.	Tacora	125	0.75	5,300	2,220
Paucarany Co.	Tacora	42	1.00	1,950	1,600
Vaccaro Bros.	Tacora	70	0.80	4,800	2,100
Totals and average		527	$0.93	21,550	19,320

Chile is bounded on the east by the crest of the Andes Mountains—one might almost say "by a wall of extinct volcanoes." There is an unbroken chain of volcanic peaks from Arica in the north as far south as Coquimbo. Still farther south they are more scattered, but they extend all the way down to Tierra del Fuego. Some of the volcanoes in the south of Chile are still active—notably, Chillan, Villarica, and Calbuco. Those volcanoes that bear sulphur deposits are indicated on the accompanying map.

The sulphur deposits are all of volcanic origin and are found on the flanks and in the craters of old volcanoes. Usually, the only signs of volcanism are hot springs and fumarolic activity. In most of the deposits one finds unmistakable evidence that the deposition of sulphur is still going on. In others, such as Piedra Parada and Juncalito, there is no solfataric action, and deposition ceased long ago. At Paucarany, the volcano has been almost removed by erosion, and the sulphur deposit—of recent origin—occupies the porous area which represents the neck of the old volcano. The deposits usually occur in beds, near the surface. In exceptional formations sulphur is found filling large cracks and gash veins in the bleached country rock. In searching for the deposits one needs no "Guide to Prospecting." Wherever sulphur vapors have been liberated the surrounding rock has been completely leached of its femic minerals, and these bleached outcrops are visible for miles. A white mountainside does not necessarily mean the existence of a sulphur deposit, but the absence of bleaching implies the absence of sulphur. It is probable that early eruptions so shattered the mountain as to form innumerable small cracks and crevices. The sulphur-laden vapors, prin-



Map of Chile, showing the location of the principal sulphur deposits

cipally SO_2 and H_2S, with much steam, escaped along these cracks. Upon nearing the surface the vapors lost high temperature and pressure, and sulphur was deposited according to the following reactions:

$$2H_2S + O_2 = 2H_2O + 2S$$
$$2SO_2 + 4H_2S = 3S_2 + 4H_2O$$

Besides these there may be other reactions. Some sulphur may have been sublimed directly from its vapor. It is probable that the oxidation of hydrogen sulphide is the principal reaction in the formation of the deposits. If the surface of the mountain happens to be covered by volcanic ash or the fragmental materials of erosion, these may be sufficiently porous to contain the oxygen required for the reactions. In such circumstances the sulphur would build up around the particles of barren

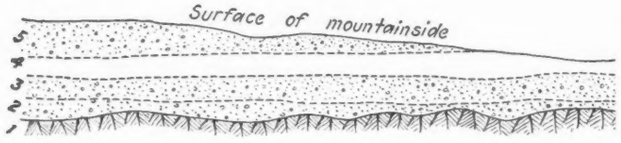


Fig. 1. Ideal conditions of deposition

1. *Fractured rock of mountainside.*
2. *Layer of fragmental material.*
3. *Layer of ore, 20 to 30 per cent sulphur.*
4. *Layer of ore, 50 to 95 per cent sulphur.*
5. *Layer of low-grade material, 5 to 25 per cent sulphur.*

material as a cementing matrix. This is the usual occurrence of the sulphur: as a matrix for the granular, bleached products of erosion. Obviously, the percentage of sulphur in such an ore depends upon the solfataric activity and the rapidity with which the area is sprinkled with the rocky fragments. A hypothetical condition is illustrated in Fig. 1. First, there is the fractured rock upon which was deposited volcanic ejectamenta or products of erosion. A period of great solfataric activity deposited the sulphur in the loose material and upon it. Rapid deposition of sulphur would give a bed of high-grade ore. With a dying down of the solfataric action there would be a greater proportion of barren material mixed with the sulphur, and consequently an ore of lower grade would be formed. Ultimately, solfataric action ceases and the surface is composed of barren, bleached products of erosion.

Beds May Be Thirty Feet Thick

In some deposits the bed may be 20 to 30 ft. thick and of 95 per cent ore. The thickness of the covering of loose barren material may be 20 ft. or more; or it may attain great thickness and then be removed by erosion, leaving the sulphur bed outcropping. Obviously, a great variety of conditions may exist. The fractured masses of country rock through which the vapors have escaped to the surface contain from 5 to 10 per cent of sulphur, which has been deposited along the fracture planes. This material is not of economic importance.

In exceptional instances, fractures in the rock, several feet wide, have been formed, and are filled with practically pure sulphur. It is doubtful if the sulphur in these "veins" will extend more than 30 or 40 ft. in depth. Chupiquina Mountain shows a number of these "veins," which provide a large part of the production of one company operating there.

To summarize, a typical deposit today is the result of the following conditions:

1. Volcanic activity sufficiently violent to have thoroughly fractured the body of the mountain.
2. A period of relative quiescence, with perhaps occasional eruptions of ash, but no flows of lava.
3. Abundance of sulphur vapors finding outlet to the surface through cracks in the flanks of the volcano. Deposition of sulphur, at or near the surface.
4. Climatic conditions such as to preclude rapid erosion.

Climatic Conditions Complicate Mining

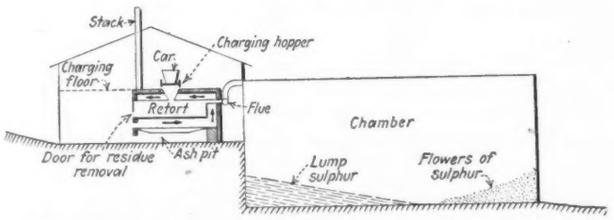
The deposits range in altitude from 13,000 ft. (Salar de Aguilar) to 20,000 ft. (Piedra Parada). At 20,000 ft. elevation respiration, at normal rate, supplies the blood with less than half the oxygen supplied at sea level. The average individual can exert himself no more than to get on and off his saddle mule. Even the Chilean miners, accustomed to altitudes up to 10,000 ft., are unable to accomplish much at altitudes in excess of 16,000 ft. The Bolivian Indians, reared to such conditions, are the only people who can stand the hardships. The extreme cold at such altitudes also reduces efficiency of labor. Imagine working in a place where the maximum mid-day temperature ever recorded was 4 deg. C.! Add to this extreme cold a wind which never ceases and usually assumes hurricane force between noon and sunset, and the human being, whose vitality already has been reduced by lack of oxygen, suffers severely.

Tacora District Accounts for Most of the Output

Tacora and Chupiquina are twin mountains situated about six miles west of Ancara station on the Arica-La Paz railway. There are three producing companies operating on Tacora. On Chupiquina there are two, one of which is among those operating on Tacora. The mines on Tacora are larger and more accessible than those on Chupiquina. On Tacora the deposits occur as beds of sulphur conforming in slope to the surface of the hill and overlain by 1 to 2 m. of barren, loose, bleached material. The workable beds vary in thickness from 24 in. up to 8 ft. and the grade ranges from 50 to 90 per cent sulphur.

Mining Methods Are Primitive

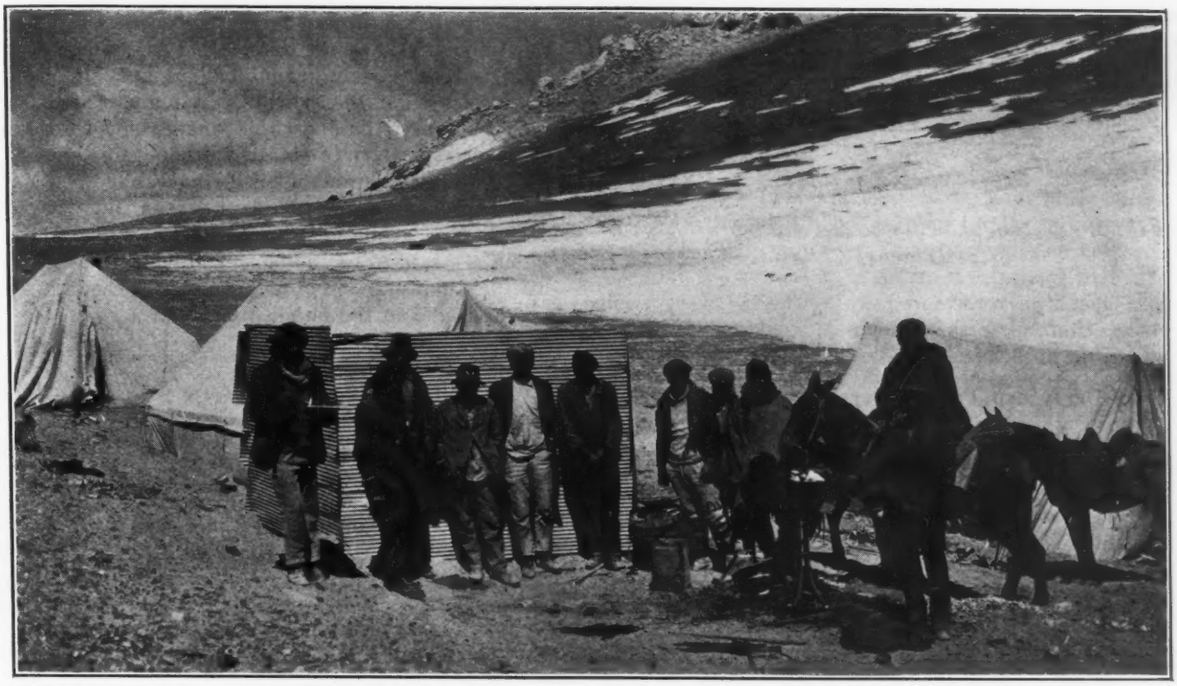
There is no system to the mining. The producers purchase per hundredweight of ore, of a specified grade, delivered to their loading yard or refinery. The miner



Sketch showing arrangement of a typical refinery

selects a likely looking place, and proceeds to "dig himself in." He throws his waste where he wills, and recovers about 50 per cent of the ore. He may come along a week later and rehandle his waste so as to get at ore that should have been removed first. All ore that breaks fine is lost. The "method" seems to have been transplanted, intact, from the nitrate fields.

The ore is sorted by hand in the diggings and when a miner has a sufficiently large pile it is sacked, loaded on llamas, and taken to the yard to be weighed. The "patron," to be safe, deducts 10 per cent. The Indian, placidly chewing his "coca," is pleased that it isn't more.



Sulphur miners at Piedra Parada, in Chile. The elevation is 19,500 ft.

Sometimes the mine catches fire. It may be quickly smothered by throwing on more sulphur. If it gets out of control thousands of tons may either burn or melt and run down the hillside.

It is probable that on Tacora Mountain there are 205 acres of ground underlain by sulphur ore. Assuming an average thickness of 3½ ft. and average grade of 50 per cent would give a total of 1,500,000 tons of 50 per cent ore. These figures are set down only to convey an idea of the size of the deposits, and are not an attempt at an exact estimate.

On Chupiquina Mountain there are bedded deposits like those on Tacora, and also "veins" of sulphur. The total sulphur-bearing ground on Chupiquina may be estimated at 125 acres. The vein deposits in this area probably contain 180,000 tons of 80 per cent sulphur ore. The bedded deposits contain probably 350,000 tons of 50 per cent ore. The combined tonnage would be around 530,000 tons of 60 per cent ore.

Refining Is a Process of Distillation

In the refining process two products are obtained: flowers and granulated sulphur. The flowers, used in disinfecting vineyards, bring a much higher price than the equally pure granulated sulphur. The refiner naturally aims to produce as high a proportion as possible of flowers.

With one exception, all refiners use the same process. This consists of placing a charge of sulphur ore in a cast-iron retort, excluding air, and by applying external heat volatilizing the sulphur in the charge. The vapors pass to a condensing chamber, where they yield the finely divided amorphous powder known as flowers. As the chamber where sublimation takes place has no circulation, the temperature near the point of entrance of the vapors is usually above the melting point of sulphur (115 deg. C.). About 50 per cent of the sulphur coming from the retort forms in the chamber as a liquid, which runs down and covers the floor near that end of the chamber. Later, this is broken up and sold as granulated sulphur. Both products are equally pure—99.7 per cent S being a typical assay.

Cast-Iron Retorts Are Used

The retorts are of cast iron, 6 ft. long, 3 ft. wide, and 18 in. high. The bottom is flat, and the top is rounded to an arch. They are similar in shape to the ordinary muffle furnace for assaying. In the center of the top there is an opening for charging. At the back end there is an opening to the flue which carries the volatilized sulphur to the condensing chamber. In the front is a door through which the unburned residue is removed after each run. Once charged, the openings in front and on top are sealed, the fires are quickened, and volatilization proceeds. The firebox is arranged to give two passes of the hot gases in contact with the retort. The first passage is under and to the rear. The gases then pass to the front along the sides and top of the retort. Flues conduct the gases to the stack. The sketch on the preceding page shows, in a general way, how the treatment is conducted.

Above the retort is a funnel-shaped hopper which holds one charge for the retort. This is filled with ore, and the heat from below melts the sulphur and prepares it for introduction into the retort as the next charge. Along the top of the line of retorts is a track by which the ore is brought in small cars to the charging hoppers.

The unburned residue of the ore, and also the ashes from the fixebox, are dumped into wheelbarrows and taken to the dump. Each charge is about 500 lb.; eight charges can be run in twenty-four hours. *Yareta* is used for fuel. One ton of charge requires 1,250 lb. of *yareta*.

The chambers are opened at intervals of four or five days. The flowers are sacked for shipment without further treatment. The lump sulphur is crushed to about 2-in. size and also sacked. The plant operates in two twelve-hour shifts, and requires eight men per shift.

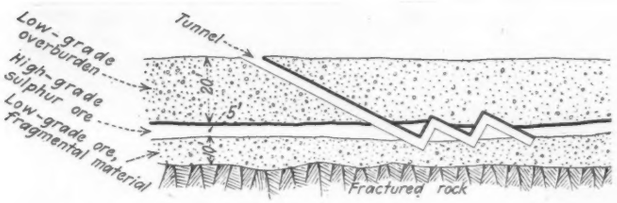


Fig. 3. Section showing tunnel mining of sulphur at Ollaque, Chile

The cast-iron retorts require replacing every twelve months, this being the principal item of maintenance cost.

Cost Delivered at Tidewater Is $23.12 per Ton

The detailed cost per ton of producing sublimed sulphur under the conditions outlined is as follows:

Mining two tons of ore at $1.28	$2.56
Refining, including $2.40 for fuel	7.68
Freight (llama pack train) to railroad, fifteen miles	3.52
Wear and tear on sacks, miscellaneous costs	3.52
Total per ton of sublimed sulphur	$17.28
Freight by rail to Arica, ninety-eight miles	5.84
Total f.o.b. Arica	$23.12

Nothing is included in the above for depletion of ore or depreciation of plant.

The sulphur produced is half flowers and half granulated. The flowers sell in Arica for $50 per ton and the granulated for about $27 per ton. The average selling price for the product of the refinery is around $38.50 per ton, which yields a profit of more than $15 per ton. A properly equipped refinery and a narrow-gage railway to connect with the Arica-La Paz railway would increase the profit greatly.

Motor Trucks Used for Transporting Ore

Muecke & Co., operating on Chupiquina, have been the most progressive of the operators in the Tacora district. They have a three-mile aërial tramway from the mine to the foot of the mountain. From the lower end of the tramway the ore is carried two and one-half miles in motor truck to the refinery. The refinery consists of two parts. One section uses the retort method already described. The other section refines by steam. The ore is charged into a vertical cylindrical retort about 12 ft. high and 5 ft. in diameter. The cylinder has hemispherical ends. In the lower end is a screen upon which are retained the impurities in the ore. The molten sulphur passes through the screen to the hemispherical lower end, which is steam-jacketed for keeping the sulphur molten. On a level with the screen is a door for the removal of the impurities retained on the screen.

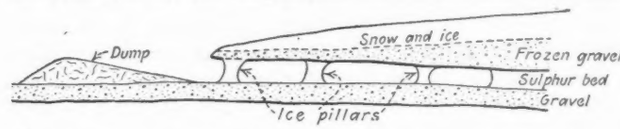


Fig. 4. Sections showing method of supporting workings by means of ice pillars at Aucanquilcha, Chile

The charging door is at the top of the upper hemisphere. The doors are steam-tight. Once charged the cylinder is filled with steam under 80-lb. pressure. The steam melts the sulphur, which runs to the bottom through the screen and collects in the steam-jacketed receptacle there. The molten sulphur is tapped periodically and run into moulds. The blocks are crushed and shipped in sacks as granulated sulphur.

The principal objection to this process is that all of the impurities are not removed. Another objection is that it produces only granulated sulphur, which sells for much less than the flowers. Attempts have recently been made to grind finely this steam-refined sulphur, and by air classification to obtain a product fine enough to be used as a disinfectant. It is claimed that these artificial flowers adhere better to plant leaves, but they do not contain the small amounts of free H_2SO_4 and H_2SO_3 which are said to be the beneficially active agents in the sublimed flowers. Also, any arsenic present in the ore will be found in the finished product.

Deposit at Paucarany Is Covered with Overburden

About fifteen miles north of Tacora, at Paucarany, is a small producer. The ore comes principally from what was once the neck of a volcano. The volcano has been eroded on three sides, and the deposit is on a level with the surrounding country. It is a bedded deposit, formed after the erosion of the volcano. It is covered by from 10 to 30 ft. of overburden, the removal of which makes mining expensive. However, the relatively low altitude of the deposit (14,500 ft.) and the situation in a valley where there is abundant pasturage for the llamas, compensates for the greater mining cost. South of Tacora, in the order named, are the following volcanoes: Guallatire, Puquintica, Surire, Mulluri, Pumire, Isluga, Caraquima, Lirima, Cancosa, and Porquesa. All of these are reported as containing sulphur deposits, some of them extensive and of high-grade ore. At present, because of lack of transport facilities, these deposits are not being worked but they will be available if required in the future.

One Producer in the Ollague District

In the Ollague district there are two mountains containing large sulphur deposits. These are Ollague and Aucanquilcha. Ollague volcano lies six miles east of the village of that name. Aucanquilcha is fifteen miles west of the same point. Ollague village is 437 km. from Antofagasta on the Antofagasta-Bolivia railway. Ollague volcano, with its column of steam, is a familiar sight to any who have traveled from Antofagasta into Bolivia.

The deposits on Ollague volcano are similar to those already described on Tacora Mountain. The area of the sulphur-bearing ground is about forty-two acres. The hillside is steep, averaging about 35 deg. The deposit is overlain by from two to six meters of overburden, but this does not interfere seriously with mining. The sulphur beds conform to the slope of the hill. The thickness of the bed is from one to three meters, and the average grade probably around 75 per cent.

Fifteen miles west of Ollague village is Aucanquilcha Mountain. The top of the mountain is 20,047 ft. above sea level. The mountain is irregular in outline, and is not at all suggestive of a volcano. The only signs of volcanism are the few sulphurous exhalations associated with the sulphur beds.

Ice Pillars Used for Support in Mine Workings

The bed is from 3 to 15 ft. thick and averages about 90 per cent sulphur. As the ore is covered by weathered material and snow, mining is done underground. At mid-day, during the summer, the snow melts a little, and the water trickling into the workings is so controlled that when it freezes—which it does quickly in the mine—pillars of ice are built up for supporting the roof!

Most miners would be afraid of a thaw, but as the maximum temperature ever recorded in that locality was 4 deg. C. there seems no danger of the pillars giving way.

The refinery at Ollague is similar in general design and operation to the one at Tacora. Besides their refining business, the Carrasco Brothers, who own practically all of the sulphur ground on Aucanquilcha, have sold four or five thousand tons of 85 per cent ore to the Chile Exploration Co. each year.

The llama of the Bolivian Indian. Llamas are used to transport sulphur ore in Chile

The Ollague district has somewhat less tonnage than the Tacora district, but the ore is of better grade. Judging from areas, exposures and the grades being produced, the combined tonnage of the two mountains may be estimated at 2,000,000 tons and the grade as around 75 per cent.

The next deposits of importance begin at Llullaillaco volcano and extend to Cerro Copiapo. In this distance of 125 miles are found the deposits of Llullaillaco, Lastarria, Salar de Zufrera, Salar de Aguilar, Cerro Infieles, Piedra Parada, Juncalito, and Copiapo. Because of their remoteness from rail transportation none of these deposits have produced sulphur in commercial quantities.

At Piedra Parada is a large deposit which has been prospected by the Andes Copper Mining Co. of Potrerillos. The sulphur beds are similar to those on Tacora Mountain, which have already been described. The deposit is on the top of the mountain at an elevation of about 20,000 ft. It was systematically prospected by test pits and tunnels, and an accurate tonnage estimate was made. The difficulty of carrying an exploration work fifty-five miles from a base of supplies and at 20,000 ft. elevation can be appreciated.

The Piedra Parada deposits are relatively older than those of Tacora and Ollague. Deposition has entirely ceased, there is no solfataric action, and erosion has proceeded far enough to remove the sulphur beds in certain areas.

South of Coquimbo the next known deposit is at Tinguiririca. This leaves a stretch of 300 miles of Cordillera in which no sulphur deposits are found. Tinguiririca is ninety miles south of Santiago, and is east of the San Fernando station on the Chilean state railways. The volcano is in an inaccessible region and the difficulties of transport are enormous. Alfred P. Tupper, one of the veteran explorers of the Andes, has described Tinguiririca as one of the greatest sulphur deposits of Chile. I inspected what were claimed to be the best areas on the mountain, and decided that they were not at all comparable with the deposits farther north.

The Cerro Azufre of Chillan is on the flank of an active volcano. All around the base of the volcano are numerous vents giving off vapors. Sulphur is actively being deposited, but erosion is keeping pace with deposition, and no large deposits are found. The deposits have never been worked. They are at 8,000 ft. elevation. Here climatic conditions preclude the existence of a large deposit.

The sulphur industry in Chile is in its infancy, and as yet production is comparatively small. It is amply protected by tariff and is already a profitable business. Markets in Argentina, Brazil, and Peru are capable of great expansion. Fairly complete information on the greater part of the Chilean Cordillera is available, but the deposits between Guallatire and Porduesa have not

Sulphur-bearing ground at Salar de Aguilar, Chile. The white shows the bleached surface

been developed, and little is known of their potential output. It is quite possible that one or two of these little-known sulphur deposits may prove to be as large as Tacora.

Until more is known of the Guallatire-Porquesa deposits a complete estimate of Chile's sulphur resources will be impossible. There are, however, sufficient data on the rest of the deposits to show the large reserves of the country. I have estimated the various deposits as follows:

TABLE 4. ESTIMATED AVAILABLE SUPPLY OF SULPHUR IN CHILE

Locality	Available Ore, Tons	Average Grade, Per Cent	Sulphur, Tons
Tacora Mountain	1,500,000	50	750,000
Chupiquina Mountain	530,000	60	318,000
Ollague district	2,000,000	75	1,500,000
Salar de Azufrera (three deposits)	1,000,000	60	600,000
Piedra Parada (approximately)	500,000	50	250,000
Totals and average	5,530,000	62	3,418,000

These estimates are only approximate, and probably err on the side of conservatism. With the gradual but inevitable exhaustion of the deposits of Japan and Sicily, there remain only two large known sources of sulphur —namely, those of the Gulf Coast and those of the Chilean Andes. The development and large-scale exploitation of the Chilean deposits is only a question of time.

Platinum in the Quartz Veins of Southwest Oregon

Traced in Some Cases to Lode Deposits— Blue Quartz in Highland Mine Yielded High Per Cent

BY A. E. KELLOGG

PLATINUM, like chrome, in southwest Oregon is closely associated with serpentine. The native alloy of platinum, iridium and osmium, in which platinum is found in nearly all the gravel deposits of this region, is apparently derived from the serpentine. That is, these metals are believed to be the primary constituents of the igneous rock, which have altered to serpentine. It is also believed that the ultimate source of the gold placers in this region, like those of California, is in the serpentine and the olivine-bearing rocks of the Sierra Nevadas and tributary ranges, which are in a part of the drainage basins of the streams.

The platinum that is associated with the gold in the placer workings of the district has in but a few instances been traced to lode deposits containing the metal in the native form. A roughness of the platinum, and in some specimens a black or a brownish coating, which is apparently iron oxide, indicate proximity to its source.

In the Riddle Quadrangle, the serpentines have resulted chiefly from the decomposition of the peridotites and the pyroxenites, but in some areas they are probably derived from the decomposition of the basic phases of the greenstone. Much of this serpentine shows shear zones and slickensided surfaces.

The great serpentine dike extending from Siskiyou County, Cal., first makes its appearance in Oregon in the Upper Applegate district. This area is occupied largely by old Paleozoic sedimentary rocks, with interbedded sills and flows of andesitic character. In places these bedded rocks are penetrated by dikes of dark igneous rocks and also large irregular masses of tonalite. The sediments in general strike about north 20 deg. east and dip at an high angle to the east. They have perhaps been overturned, so that the oldest beds now lie above the younger. On this basis the oldest Paleozoic rocks are the argillites and sandstones, containing limestone lenses near Watkins. They have been intruded by andesite and serpentine dikes, and, in some places, are highly altered. They are also modified by intrusions of tonalite. Serpentine, derived in part from dunite, is abundant on Red Mountain, which obtained its name from the color of the thoroughly oxidized soils derived from it and similar highly ferruginous rocks. The serpentine is cut by seams, some of which are occupied by chlorite and other talc. On the eastern part of this mountain, some of the serpentine is derived from the alteration of amphibolite. These dikes are found in many places in this part of the state.

In 1916 the manager of the Highland mine, in the Gold Hill district, was puzzled at the smelter report on a shipment of concentrates. Besides containing 14.12 oz. of gold and 3.24 oz. of silver, it also contained 0.32 oz. of platinum. The ore giving this result was taken on the 100 level of the mine. The foot wall of the vein showed schist and granite, and the hanging wall is made up of serpentine, schist, and granite.

According to Parks and Swartley, of the Oregon Bureau of Mines, the Highland group of mines is situated twelve miles southwest of Gold Hill, on the right-hand fork of Foots Creek, at an elevation of 2,600 ft. It was first worked about twenty-five years ago. The present workings are confined to the oxide zone, the old workings being more extensive. The vein strikes northeast and dips south 35 deg. east. The country rock is a micaceous sandstone.

The owners of the mine, in an attempt to discover the source of the platinum, found in the shipment sampled the walls of the vein but no trace of platinum. They then looked to the vein matter for the source. The vein matter is mingled with quartz of three hues—rose, amber, and blue. The blue quartz, more dense in its composition than the others, is pitted throughout with small cavities, which are lined with a sooty black mineral and filled with decomposed ferrous matter. In crushing and panning this blue quartz, it invariably yields a high per cent of platinum, and assays give a higher per cent. The rose and amber quartz show no platinum.

Surprising values in platinum quartz were found two years ago in Curry County, running from 10 to 20 oz. per ton. It is claimed that these deposits have been traced for nearly twenty miles from northeast to southwest, ending in the vicinity of the mouth of the Sixes River. Diller[1] wrote of the platinum possibilities of the Sixes River district in a paper published nearly twenty years ago.

Some experienced mining men were slow to believe that the reported finds were realities, declaring that platinum had never been found in ore and that the mineral that caused the excitement in Curry County was something else than platinum, this despite the fact that all of the placer diggings in the region were productive in platinum.

[1]U. S. Geological Survey, Folio 89, p. 6, 1903.

Friction Factors in Ventilating Pipe

Results of a Series of Experiments at the University of California—Little Difference Between Metal and Wood Pipe

BY WALTER S. WEEKS, WESLEY P. GOSS, AND GEORGE H. WARREN

A SERIES of experiments was recently made at the University of California to determine the friction factors in metal, wood, and canvas ventilating pipe. We use the term "friction factor" instead of "coefficient of friction" because the latter term has a distinct and special meaning in mechanics.

The formula in common use to express drop in pressure in a ventilating duct is

$$P = \frac{KSV^2}{A} \qquad (1)$$

P = drop in pressure in pounds per square foot.
K = friction factor.
S = rubbing surface in square feet.
V = velocity in feet per minute.
A = cross-sectional area of duct in square feet.

This formula is derived from the Fanning formula for turbulent flow, which is

$$h_f = \frac{4 f l v^2}{d 2 g}$$

h_f = drop in pressure in feet of head.
l = length of pipe in feet.
v = velocity in feet per second.
d = diameter in feet.
g = acceleration due to gravity.
Let w = density in pounds per cubic foot.
v = velocity in feet per minute.
A = area in square feet.

Then $h_f = \frac{P}{w}$

$$\frac{P}{w} = \frac{4 f l v^2}{d 2 g 3600}$$

If we multiply numerator and denominator by $\frac{\pi d}{4}$

$$P = \left(\frac{f}{3600 \times 2 g}\right) \frac{w S V^2}{A}$$

Let $\frac{f}{3600 \times 2 g}$ be represented by a new factor, C, then simplify

$$P = \frac{C w S V^2}{A}$$

It is seen that the factor K is in reality a factor C multiplied by the density. Investigators who publish values of K should give the density at which it is determined or else divide K by the density and give the factor C. An extremely accurate description of the duct should also be given.

The friction factor, whether K or C be used, cannot be expressed in units. The factor C is a variable, and its value is affected by the diameter of the pipe, the specific gravity of the gas, the velocity, and the pipe surface.[1]

The condition of the pipes used in mine work varies so much that the calculation of the factors for different velocities and diameters would be a useless refinement. The formula for drop in pressure is used for determining the water-gage pressure on a pipe when a given amount of air is flowing, so the simplest procedure is to determine the factor in one of the commonly used smaller diameter pipes with low velocity. Any increase in diameter or velocity will make the factor smaller, so we shall be on the safe side. If the pipe is dented or extremely rough, a larger factor must be assumed.

A study of metal and canvas tubing was made at the same time. The canvas tubing was connected to the fan and the metal pipe was arranged in series with it, so the same air passed through both. It was found necessary to restrict the flow of air at the end of the metal pipe by an orifice in order to hold sufficient pressure in the canvas tubing to keep it inflated. A diagram of the apparatus is shown above.

The fan used was a multivane No. 2 exhauster directly connected to a shunt-wound motor. Accurate speed control was obtained by a sliding rheostat in the armature. Speed was indicated by a Weston electrical indicating speed counter attached to the motor shaft.

The drop in pressure was measured by a specially designed inclined manometer which could be accurately set to the nearest minute of arc. With a 20-to-1 slope the pressure could be read to 0.0005 in. of water.

At the points where pressure readings were to be taken, pin-hole tubes were inserted. Small lead pipes connected these to the manometer. The single manometer was used for all pressure determinations. The velocity was measured with the pitot tube at the point X. Vertical and horizontal traverses were made with a total of twelve readings for each velocity.

DESCRIPTION OF PROCEDURE FOR TESTS

The procedure in taking a set of readings was as follows: The manometer was set at a 20-to-1 slope. Drop in pressure between any two points could be measured by connecting those points to the opposite legs of the manometer.

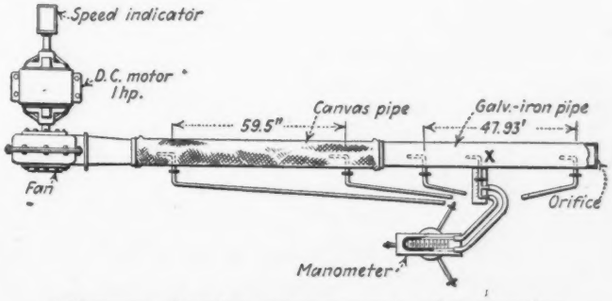


Diagram showing arrangements of apparatus

Drop in pressure in both metal and canvas pipes was first measured. Then the traverses for velocity were made. The readings were then repeated. Next the slope of the manometer was changed to 10 to 1, and the above procedure repeated. The speed was held constant during the test. The density of the air inside of the pipe was calculated from barometric, hygrometric, and temperature determinations.

[1] "The Flow of Fluids Through Commercial Pipe Lines," Robert E. Wilson, W. H. McAdams, and M. Seltzer, *Journal of Industrial and Engineering Chemistry*, February, 1922.

The canvas pipe had an internal diameter of 10.9 in., and was in 20-ft. lengths. The outside was painted with an asphalt paint to stop leaks, and the joints were caulked. The metal pipe was in 14-ft. lengths, with slip joints. A length was made from five sections riveted together. The pipe was dipped, and all joints were taped and painted. The average internal diameter was 11.8 in. The factors for steel and canvas tubing are given in Table 1. Each of these factors is the average of four determinations.

TABLE 1. FACTORS FOR STEEL AND CANVAS PIPE

No.	Pipe	Water Gage at Fan, Inches	Cubic Feet per Minute	Density Pounds per Cubic Foot	C	$K = C \times$ Density
1	Steel	1.25	981	0.0760	0.0000000206	0.00000000156
2	Canvas	1.25	981	0.0760	0.0000000278	0.00000000211
3	Steel	1.6	1,150	0.0760	0.0000000191	0.00000000145
4	Canvas	1.6	1,150	0.0760	0.0000000261	0.00000000198

Wood, Metal, and Canvas Pipe Used

The wood pipe used for determinations was a standard wire-wound wood-stave pipe with slip joints. The inside diameter was 12.5 in. One hundred feet of pipe was connected to the fan. The drop in pressure was taken over a length of 86 ft. There were seven joints in this 86 ft. The factors were determined for different velocities of air obtained by varying the speed of the fan. No orifice was used on the pipe. A 10-to-1 magnification was used on the manometer. The results are shown in Table 2.

TABLE 2. FACTORS FOR WOOD PIPE

No.	Water Gage at Fan, Inches	Cubic Feet per Minute	Density, Pounds per Cubic Foot	C	$K = C \times$ Density
1	0.190	1,200	0.0762	0.0000000189	0.00000000144
2	0.418	1,830	0.0761	0.0000000179	0.00000000136
3	0.556	2,120	0.0761	0.0000000176	0.00000000134
4	0.606	2,220	0.0761	0.0000000175	0.00000000133

A study of Table 1 shows that the factor for canvas tubing is 1.36 times the factor for metal pipe. A study of Table 2 shows clearly that the factor decreases with the increase of velocity. To compare the factors of metal and wood pipe we must use the results obtained with nearly the same velocity.

Test 3 of Table 1 is comparable to Test 1 of Table 2. This comparison shows that there is little or no difference in the factors of wood and metal pipes.

To determine quickly the drop in pressure in a pipe through which a given amount of air is flowing, some sort of chart is necessary. The chart[2] printed in the American Blower Co.'s bulletin, "Fan Testing," is the most convenient one, in our opinion. Let us see how the friction factor used in the calculation of this chart compares with the factor which we have determined for metal pipe.

The formula used in the calculation of this chart is

$$F = \frac{kSv^2}{a}$$

F = drop in pressure in inches of water.
k = friction factor.
S = rubbing surface in square feet.
v = velocity in feet per second.
a = cross-sectional area in square inches.

This formula may be derived from the formula (1) given at the beginning of the article. The factor used in the A. B. C. formula is 100,000 times the factor K used in this paper. The k used in the building of the A. B. C. chart was 0.0002. This factor would be 0.000000002 if used in our formula (1). Comparing this with K for steel pipe, it is seen that the factor used in the chart is about 33 per cent higher than is shown by our experiments. Considering the fact that the pipe used in our experiments was in excellent condition, this does not seem an unreasonable allowance for less favorable conditions.

Accordingly, for metal and wood pipe it would seem reasonable to use the A. B. C. chart directly. For canvas tubing the drop in pressures taken from the chart should be multiplied by 1.4. If it is desired to allow for higher density, the figures for drop in pressures taken from the chart should be multiplied by the factor, "actual density ÷ 0.076." In metal pipe that has been much dented or where constrictions are made in the canvas tubing, much higher factors may be necessary.

The nominal diameters of the pipes are not always accurate, and therefore the pipe should always be measured and the drops calculated for the actual diameters. If satisfactory results are to be obtained with ventilation by pipes, all leaks must be stopped.

[2] "Selection of Fans for Pipe Ventilation," by Walter S. Weeks, *Engineering and Mining Journal-Press*, May 13, 1922, p. 816.

The Sierra de Ramirez, Durango

By Alberto Terrones

The Sierra de Ramirez is situated in the San Juan de Guadalupe district, in eastern Durango, Mexico, about three miles from Rivas Station of the old Central railroad. The country is arid.

The orebodies occur in a bedded limestone, where big bonanzas have been found. The principal mineral is cerargyrite. The ores of the district are, generally speaking, easily smelted.

Only the upper orebodies have been exploited up to the present, development having been by means of adits and drifts. No shafts have been sunk in the limestone formation, for which reason the lower part of the mineralized country remains unknown. Winzes have been sunk not deeper than fifteen meters. The unaltered sulphide zone has not been touched.

The country rock is soft, though hard enough to make timbering unnecessary. The ores contain up to 50 per cent of lime, and could be easily graded or cleaned before shipping.

The mines are dry. Ancient mining methods have always been employed. Exploration by boring would be ideal in this country. As already explained, the natives follow the narrow streaks until they strike the orebodies, which in the great bonanzas have produced ore assaying from 20 kg. to 500 kg. of silver per metric ton. At the Calaverita mine, the richest ore, containing up to 75 per cent silver, was found to the amount of eighteen tons. This ore was easily reduced to sheets by hammering, being called by the natives *metal de teja*, and was so sectile that instead of being broken it was cut in mining.

From Symon Station to the mines a good wagon road has been built. Freighting costs 3.50 pesos per ton. Ten kilometers of broad-gage railroad have been recently built from Rivas Station to the mines, which will facilitate the shipping of the ores to either the Torreon or the Aguascalientes smelter. The low-grade ores are now sold to the smelters at a profit by reason of the lime contents and the absence of insoluble.

Ajo Enterprise of the New Cornelia Copper Co.—II

Calculations Based on Diamond-Drilling Proved Exceptionally Accurate and Disclosed Over 100,000,000 Tons of 1.5 per Cent Ore — Acid Leaching and Electrolytic Precipitation Adopted After Exhaustive Research by Metallurgists

By A. W. Allen
Assistant Editor, *Engineering and Mining Journal-Press*

As MENTIONED in the previous article, the holdings of the original Ajo Consolidated Copper Co., the successors to the Rendall Ore Reduction Co., had been developed to such a state that they were sold to the New Cornelia Copper Co., in 1917, for 200,000 shares of New Cornelia stock, and notes for $500,000, due in six and twelve months, with interest at 4 per cent. The exploratory work done by the Ajo Consolidated Co. was considered so thorough and so satisfactory that only a few drill holes were made to check the estimates. The ore reserves thus added to those of the New Cornelia company aggregated 21,000,000 tons, averaging 1.55 per cent copper.

The work of developing the Consolidated property had been placed in the hands of competent engineers and a reliable firm of drilling contractors; and it is interesting to note that a great saving was afterward effected by the avoidance of a complete resampling of the property. Questionable and slipshod methods of ore estimation often have been responsible for an appalling waste of time and money, because of an unnecessary duplication of labor and wastage of supplies. In mining work a guarantee of probity is worth much to the buyer and more to the seller; the Ajo Consolidated company profited as a result of this, and deservedly.

Developing New Cornelia Orebody Started in 1911

An intensive campaign of diamond drilling was begun late in 1911 to develop the New Cornelia orebody. This was for the purpose of estimating (1) the respective amounts of oxidized and sulphide ores that were available for mining by steam shovel, (2) how much had to be removed by other methods, (3) the copper content of the ores, and (4) the amounts of gold and silver present. The work of diamond drilling was placed under contract with the E. J. Longyear Co., of Minneapolis, the contractors that were engaged by the Ajo Consolidated Co. for a like purpose on the adjoining property.

Collecting Sludge for Sampling

R. D. Longyear comments, in a recent A. I. M. E. bulletin, on the sampling methods employed. The most reliable plan to adopt to collect the sludge, he says, is to see that all the water pumped down is returned, preferably to a tub, allowing the overflow to settle afterward in three or more barrels placed in series. As soon as one of these is full the overflow pipe is deflected to a second barrel, and so on. When the ore has settled sufficiently in the first barrel, the clear supernatant liquor is siphoned, and the vessel is filled again with pulp, this procedure being continued until the sample is complete. When sufficient water has been decanted from all the barrels, the sample is concentrated in one of these, in which further decantation is practiced until the pulp is of such consistence that it may be removed and dried. Both core and sludge are then assayed, and the results are averaged in proportion to their original weights.

At Ajo less than 50 per cent was recovered as core. To facilitate calculation, the engineers of the Longyear company devised a table, shown herewith, by the use of which it is possible to estimate quickly the correct average as soon as data as to weight of core and sludge have been obtained. The bit used at Ajo was such that a 1⅛-in. core resulted. The chart used[1] can be extended as desired to include any type of bit and to cover any possible character of deposit. The accuracy of the system depends on the hole being of uniform size, for the results would be vitiated if the presence of softer material led to the enlargement of the bore or to local collapse of the walls. It is, of course, assumed that all the sludge and core is recovered.

Drilling and Channel Sampling Checked Closely

The Longyear method of calculation proved to be unusually accurate so far as the Ajo orebody was concerned; for, when test pits and drifts were made to check the results, it was found that the channel sample of the test pits in the carbonate ore checked the result of the drilling to within 0.005 per cent, being that much lower; in the case of the sulphide ore the test pits and raises were within 0.05 per cent of the drilling estimate, being also that much lower; and the drifts in sulphide ore averaged only 0.02 per cent higher than did the estimate obtained by diamond drilling the corners of the blocks. This work was described[2] in detail by Ira B. Joralemon, who, as geologist for the Calumet & Arizona Co., was one of the engineers associated with the parent enterprise and in charge of development operations. From this account the following condensed statement has been prepared: The ground considered as ore-bearing was co-ordinated with east-to-west and north-to-south lines that were placed at 200-ft. intervals, the diamond-drill holes being made at the intersections. The work was begun late in 1911 and was finished in September, 1913, when eighty-four holes had been bored, varying in depth from 200 to 1,000 ft. and totaling 23,097 ft. in length. Of these, nineteen were stopped while still in ore.

After six months of diamond drilling, the checking of results was begun by means of test pits, each of which was 4 by 6 ft.; these were sunk, using Mexican and Indian labor, by means of windlass and hand drill. Letting this work on contract proved so satisfactory that up to a depth of 50 ft. it was found to be cheaper than diamond drilling. Every tenth bucketful hoisted from each hole was taken for a sample; then, after the pit was completed, it was again sampled in 5-ft. sections, by cutting a rectangular groove 3 in. deep and 6 in. wide, the product from which aggregated 500 lb.

[1] *Eng. and Min. Journ.*, March 21, 1914.
[2] *Trans.* A. I. M. E., 1914, Vol. 49, p. 605.

in weight for each 5-ft. section. This so-called channel sample proved to contain 0.15 per cent less copper than did the bucket sample; the lower of the two estimates was taken as final.

The number of test pits sunk was seventy-seven, of a combined depth of 3,955 ft., 3,606 ft. of which was in carbonate ore and 349 ft. in sulphide ore. Of this, 1,059 ft. served to check the results of holes drilled in carbonate ore; 175 ft. checked the results in sulphide ore; and 2,721 ft. of test pitting was done in advance of drilling operations.

Drifts were run on co-ordinated lines from the bottoms of two of the deepest test pits to check the diamond drilling in the sulphide zone, raises from these drifts being used to check the estimate obtained by drilling. The material broken on each round was hoisted separately, dumped on an iron plate, mixed, and shoveled to waste after every tenth shovelful had been reserved to form the basis of a sample to be reduced subsequently. The total length of drifting in sulphide ore amounted to 1,513 ft., and the combined sinking and raising on drill holes in sulphide ore was 307 ft. At the conclusion of this development work an estimate of ore available within the zone of exploration, based on a minimum of 1 per cent copper, was as follows:

	Tons	Copper Per Cent
Carbonate and sulphide ores	40,258,000	1.51
Available for mining by steam shovel	32,481,200	1.54
Not available for mining by steam shovel, sulphide ore	7,776,800	1.40
Rock to be removed to make steam-shovel tonnage available	2,308,400	0.63

As stated previously, the purchase of the Ajo Consolidated property in 1917 resulted in the acquisition of an additional 21,000,000 tons of ore averaging 1.55 per cent copper. Early in 1919 a large and rich body of sulphide ore, which contained from 4 to 77.7 per cent copper, was opened on the 360-ft. level of this ground. It was planned to ship the high-grade ore to the smelter at Douglas, retaining the low-grade material for treatment in a flotation plant that will supersede or will operate concurrently with the existing leaching plant. The value of the gold and silver in the low-grade ore amounts to about 35c. per ton; the gold and silver in the carbonate ore are not recovered. Much of that in the sulphide ore can be recovered by the flotation of the ore and the smelting of the concentrate produced.

It is doubtful whether the inception of any other important metallurgical operation has exceeded in thoroughness, care, and technical skill the preliminaries to the design and erection of the existing leaching plant at Ajo. The contributions to contemporary technical literature in this connection, particularly in reference to the leaching of copper ores, have been unusually varied and complete; all of these have appeared in the *Transactions* of the Institute. This was to be expected, for Dr. Ricketts was the president of that organization in 1916; and, in addition to his manifold activities for the betterment of the profession and the advance of technology, he was and is a member of the committee dealing with copper refining, the purpose of which is to obtain papers of high merit for the *Transactions* of the society. The published articles describing the experimental treatment of the ore at Ajo have become standard works of reference, and to disregard any of them would be to ignore the opinions and experiences of those who are exceptionally well qualified to speak with authority; therefore they will be quoted fully in the summary that follows:

TABLE OF PERCENTAGES OR MULTIPLIERS FOR DIAMOND-DRILL SAMPLES

No. In. of Core	E Extra Heavy Bit		E Medium Bit		E Standard Bit		E Mesaba Bit		A Bit		N Bit	
	Cuttings	Core	Cuttings	Core	Cuttings	Core	Cuttings	Core	Cuttings	Core	Cuttings	Core
1	99.6	0.4	99.5	0.5	99.4	0.6	99.4	0.6	99.4	0.6	99.2	0.8
2	99.2	0.8	99.0	1.0	98.9	1.1	98.9	1.1	98.8	1.2	98.3	1.7
3	98.8	1.2	98.5	1.5	98.3	1.7	98.3	1.7	98.2	1.8	97.5	2.5
4	98.3	1.7	98.1	1.9	97.8	2.2	97.7	2.3	97.6	2.4	96.6	3.4
5	97.9	2.1	97.6	2.4	97.2	2.8	97.2	2.8	97.0	3.0	95.8	4.2
6	97.5	2.5	97.1	2.9	96.6	3.4	96.6	3.4	96.4	3.6	94.9	5.1
7	97.1	2.9	96.6	3.4	96.1	3.9	96.0	4.0	95.8	4.2	94.1	5.9
8	96.6	3.4	96.1	3.9	95.5	4.5	95.5	4.5	95.2	4.8	93.2	6.8
9	96.2	3.8	95.6	4.4	95.0	5.0	94.9	5.1	94.6	5.4	92.4	7.6
10	95.8	4.2	95.1	4.9	94.4	5.6	94.3	5.7	93.9	6.1	91.6	8.4
11	95.4	4.6	94.7	5.3	93.8	6.2	93.8	6.2	93.3	6.7	90.7	9.3
2	94.9	5.1	94.2	5.8	93.3	6.7	93.2	6.8	92.7	7.3	89.9	10.1
3	94.5	5.5	93.7	6.3	92.7	7.3	92.6	7.4	92.1	7.9	89.1	10.9
4	94.1	5.9	93.2	6.8	92.2	7.8	92.1	7.9	91.5	8.5	88.2	11.8
5	93.7	6.3	92.7	7.3	91.6	8.4	91.5	8.5	90.9	9.1	87.3	12.7
6	93.3	6.7	92.2	7.8	91.0	9.0	90.9	9.1	90.3	9.7	86.5	13.5
7	92.9	7.1	91.7	8.3	90.5	9.5	90.4	9.6	89.7	10.3	85.1	14.3
8	92.5	7.5	91.3	8.7	89.9	10.1	89.8	10.2	89.1	10.9	84.8	15.2
9	92.1	7.9	90.8	9.2	89.4	10.6	89.2	10.8	88.5	11.5	84.0	16.0
20	91.7	8.3	90.3	9.7	88.8	11.2	88.7	11.3	87.8	12.2	83.1	16.9
21	91 3	8.7	89.8	10.2	88.2	11.8	88.1	11.9	87.2	12.8	82.2	17.8
2	90.8	9.2	89.3	10.7	87 7	12.3	87.5	12.5	86.6	13.4	81.4	18.6
3	90.4	9.6	88.8	11 2	87 1	12.9	87.0	13.0	86.0	14.0	80.5	19.5
4	90.0	10.0	88.3	11.7	86.6	13.4	86.4	13.6	85.4	14.6	79.7	20.3
5	89.6	10.4	87.9	12.1	86.0	14.0	85.8	14.2	84.8	15.2	78.9	21.1
6	89 1	10.9	87 4	12.6	85.4	14.6	85.3	14.7	84.2	15.8	78.1	21.9
7	88 7	11.3	86.9	13.1	84.9	15.1	84.7	15.3	83.6	16.4	77.3	22.7
8	88.3	11 7	86.4	13.6	84.3	15.7	84.1	15.9	83.0	17.0	76.4	23.6
9	87.9	12.1	85.9	14.1	83.8	16.2	83.6	16.4	82.4	17.6	75.6	24.4
30	87 5	12.5	85.4	14 6	83.2	16.8	83.0	17.0	81.8	18.2	74.7	25.3
31	87.1	12.9	84.9	15.1	82.6	17.4	82.4	17.6	81.2	18.8	73.9	26.1
2	86 7	13.3	84.4	15.6	82.1	17.9	81.9	18.1	80.6	19.4	73.0	27.0
3	86 3	13.7	83.9	16.1	81.5	18.5	81.3	18.7	80.0	20.0	72.2	27.8
4	85.8	14.2	83.5	16.5	81.0	19.0	80.7	19.3	79.4	20.6	71.3	28.7
5	85.4	14.6	83.0	17.0	80.4	19.6	80.2	19.8	78.8	21.2	70.5	29.5
6	85.0	15 0	82.5	17.5	79.8	20.2	79.6	20.4	78.2	21.8	69.6	30.4
7	84 6	15 4	82.0	18.0	79.3	20.7	79.0	21.0	77.6	22.4	68.8	31.2
8	84.1	15.9	81.5	18.5	78.7	21.3	78.5	21.5	77.0	23.0	67.9	32.1
9	83.7	16 3	81.0	19.0	78.2	21.8	77.9	22.1	76.4	23.6	67.1	32.9
40	83 3	16 7	80.5	19.5	77.6	22.4	77.3	22.7	75.7	24.3	66.3	33.7
41	82.9	17 1	80 1	19.9	77.0	23.0	76.8	23.2	75.1	24.9	65.4	34.6
2	82.4	17 6	79.6	20.4	76.5	23.5	76.2	23.8	74.5	25.5	64.6	35.4
3	82.0	18.0	79 1	20.9	75.9	24.1	75.6	24.4	73.9	26.1	63.8	36.2
4	81 6	18.4	78 6	21 4	75.4	24.6	75.1	24.9	73.3	26.7	62.9	37.1
5	81 2	18.8	78 1	21.9	74.8	25.2	74.5	25.5	72.7	27.3	62.0	38.0
6	80 8	19 2	77 6	22.4	74.2	25.8	73.9	26.1	72.1	27.9	61.2	38.8
7	80.4	19.6	77.1	22.9	73.7	26.3	73.4	26.6	71.5	28.5	60.4	39.6
8	80.0	20.0	76.7	23.3	73.1	26.9	72.8	27.2	70.9	29.1	59.5	40.5
9	79 6	20.4	76.2	23.8	72 6	27.4	72.2	27.8	70.3	29.7	58.7	41.3
50	79 2	20 8	75 7	24 3	72 0	28.0	71.7	28.3	69.6	30.4	57.8	42.2
51	78 8	21 2	75 2	24.8	71 4	28.6	71 1	28.9	69.0	31.0	56.9	43.1
2	78 3	21 7	74 7	25 3	70.9	29.1	70.5	29.5	68.4	31.6	56.1	43.9
3	77 9	22.1	74 2	25 8	70.3	29.7	70.0	30.0	67.8	32.2	55.2	44.8
4	77 5	22.5	73 7	26 3	69.8	30.2	69.4	30.6	67.2	32.8	54.4	45.6
5	77 1	22.9	73 3	26 7	69.2	30.8	68.8	31.2	66.6	33.4	53.6	46.4
6	76 6	23.4	72.8	27 2	68.6	31.4	68.3	31.7	66.0	34.0	52.8	47.2
7	76 2	23 8	72 3	27 7	68.1	31.9	67.7	32.3	65.4	34 6	52.0	48.0
8	75 8	24 2	71 8	28 2	67.5	32.5	67.1	32.9	64.8	35.2	51.1	48.9
9	75 4	24 6	71 3	28 7	67.0	33.0	66.6	33.4	64.2	35.8	50.2	49.8
60	75 0	25 0	70 8	29 2	66.4	33.6	66.0	34 0	63 6	36.4	49.3	50.7

Note:—The values of the separate assays made for cuttings and core in a 5-ft. run should be multiplied by the respective percentages found in the column headed by the size of the bit used, opposite the number of inches of core recovered. The results are to be added and divided by 100 for the average assay for the sample.

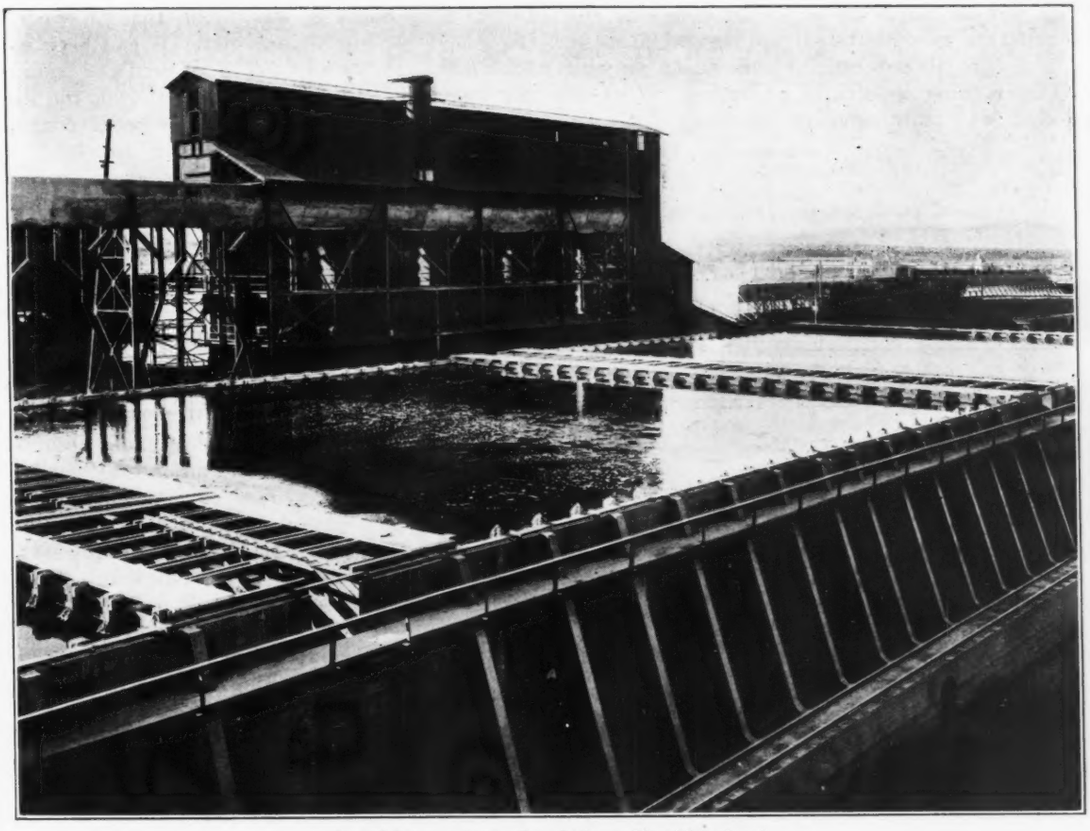
A description of the experimental work undertaken may be prefaced best by referring to a paper[3] by Dr. Ricketts, in which he discussed the various problems that were given consideration by the technicians and engineers in control of the metallurgical destinies of the New Cornelia company, with particular reference to the treatment of the immense available amount of low-grade and soluble copper ore. In this article Dr. Ricketts emphasized the fact that the metallurgical field of the copper industry has expanded greatly during recent years; copper ores are usually lean and diverse in character and must be treated on a large scale. The operating and consulting staffs of the principal mining companies have been enlarged and organized, and no great capital expenditure is now sanctioned until the subject has been given exhaustive consideration and until recommendations have been made by a highly organized force of specialists.

Value of Technical Publicity Demonstrated

Dr. Ricketts' ideas on technical publicity may be summed in the statement that "for the advancement of our art we should deliberately discuss subjects

[3] *Trans.* A. I. M. E., 1915, Vol. 51, p. 737.

among ourselves, in order to do away with the idiosyncracies of the individual and in order to gain a comprehensive view representing the best thoughts of many men." This sentiment forms the keystone of the policy of the New Cornelia company in regard to the development of a suitable process for the treatment of the ore at Ajo. The past history of the companies that a decade or so ago controlled the deposits was too bizarre to convey a lesson to an intelligent engineer; but there would be fewer metallurgical fiascoes, not only in the base-metal but also in the precious-metal industries, if engineers and capitalists would emulate the attitude taken by Dr. Ricketts when he said that



Leaching vats and sulphur-dioxide plant

"no matter how beautiful the process, simplicity and lowness of operating costs are the main features that appeal to me; complexity and higher costs must promise an increased yield that will more than offset the added expense; for, given the grade, the maximum profit per ton is demanded."

Preliminary, Downward-Leaching Tests

Owing to the comparative cheapness of operation, the high efficiency of displacement, and the ability to handle the material on a large scale, attention was directed from the start to the possibility of employing a gravity-percolation leaching process. The use of chlorine compounds was dismissed as undesirable and impracticable, and consideration was paid to the possibility of the extraction of the soluble copper by means of a dilute solution of sulphuric acid, followed by the precipitation of the metal by means of iron. The preliminary work was entrusted to Stuart Croasdale, who was assisted by Henry A. Tobelmann and James A. Potter, both of whom were afterward in charge of important work when the large plant was in operation at Ajo. This preliminary experimental work was performed at Douglas, where the Calumet & Arizona company had a smelter and now has, in addition, an acid-making plant. The ore used came from the test pits and underground workings that were opened to Ajo to check the results of diamond drilling, and the investigations were begun in July, 1912. This phase of the work has been described in detail by Mr. Croasdale.[4] He prefaces his remarks by discussing an important factor in leaching operations—the evaporation of water from the surface of large vats. During the months of June and July, 1913, the evaporation at Ajo amounted to 10.72 in. and 14.8 in., depending on whether the water was contained in a concrete or in an iron tank. Although this may appear high, it is interesting to note that it indicates only a small fraction of the evaporation occurring on the Chilean pampa, where a large-scale copper-leaching plant was erected by the Chile Exploration Co.

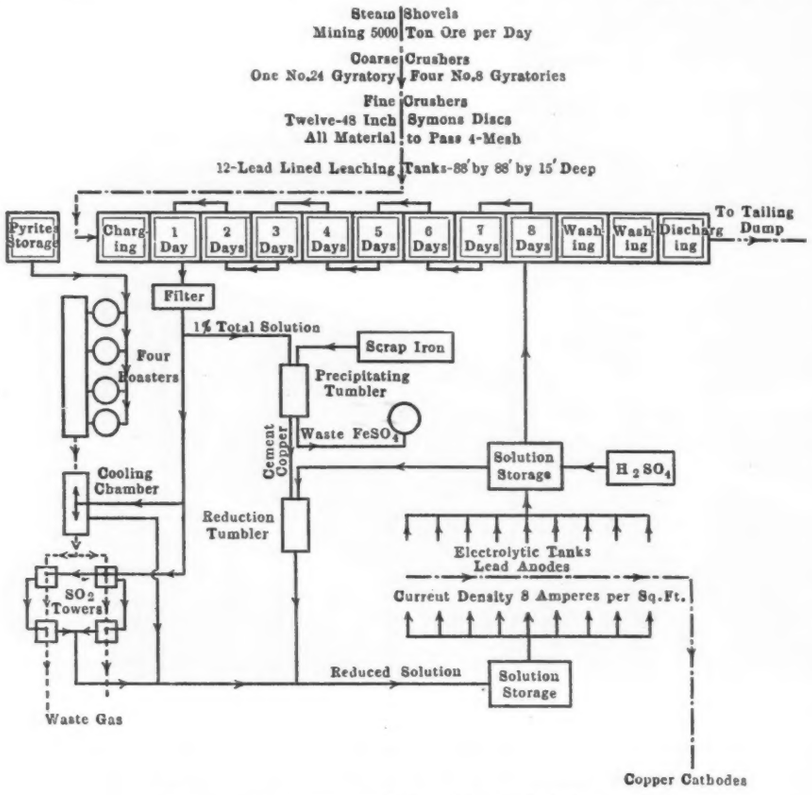
Stuart Croasdale's Researches

Mr. Croasdale, who carried out extensive volatilization tests on oxide and sulphide ores, details the consideration paid to the Henderson process of roasting with salt; of Utley Wedge's modification of a sulphatizing roast in which only a small amount of salt is added; and of Frederick Laist's idea of giving the material a preliminary roast before adding the salt.

[4] *Trans.* A. I. M. E., 1914, Vol. 49, p. 610.

By adopting the chloridizing-roast treatment, all ores from the Ajo deposit—sulphide, oxidized, and mixed—could be treated together; the extraction would be high, it was realized that the necessary crushing would be costly if not prohibitively expensive. Gravity-percolation of the roasted material would be feasible only with shallow depths; a supply of salt at a reasonable price would be essential.

The experiments showed that with the oxidized ore a chloridizing roast with salt, after crushing to 40 mesh, resulted in 86.5 per cent of the copper being volatilized and made soluble; with sulphide ore the amount was increased to 93.2 per cent. At the same time tests were made on mixed ores by the Wedge Mechanical Furnace Co. It was found, in conclusion, that mixing was advisable to secure an excess of sulphur, that crushing need not be carried beyond 20 mesh, and that from 5 to 10 per cent of salt was a suitable amount. Under these conditions an extraction of 90 to 95 per cent was anticipated in practice.



Flow sheet proposed for the 5,000-ton plant

The idea of fine crushing and roasting, however, was discarded, and attention was concentrated on the practicability of leaching the oxidized ore with a weak solution of sulphuric acid, the solvent needed at Ajo to be produced cheaply by the parent company at Douglas. A small amount of acid would be regenerated during the process if electrical precipitation were used; and the total first cost of the plant promised to be less than if fine crushing and roasting were adopted. It was proved that sufficient ferric iron would be in the solution at all times to dissolve metallic copper formed according to the equation, $Cu_2O + H_2SO_4 = CuSO_4 + H_2O + Cu$. On the other hand, it was realized that sulphuric acid would dissolve little of the copper existing as sulphide, only half of the copper in the form of cuprite, and a doubtful amount of that occurring as silicate. None of the silver and gold would be recovered by such a process. Iron and aluminum salts would pass into solution and would interfere with precipitation by electrolysis. This raised the question whether the excess acid consumed would be counterbalanced by the amount regenerated. A proportion of the iron in the ore existed in the ferric state, and this would assist in the solution of the copper minerals.

Leaching Tests at Douglas

The preliminary tests conducted by Mr. Croasdale were performed in small jars, and comparison was made between results obtained after crushing to 8 mesh and 4 mesh; in both tests a 10 per cent sulphuric-acid solution was used. After a circulating period of twenty-four hours it was found that 88.6 per cent of the copper in the 8-mesh material had been extracted, with a consumption of 3.5 lb. of acid per pound of copper dissolved. On the 4-mesh material, the extraction was 85.7 per cent, 2.8 lb. of acid being consumed per pound of copper dissolved. It was found that circulation increased the extraction without materially increasing the consumption of acid, and that crushing to 8 mesh increased the consumption of acid without materially increasing the extraction of the copper. The time of leaching was then extended to ninety-six hours and the material crushed to 2 mesh, the results, with a 10 per cent acid solution, being as good as those obtained when the material had been crushed finer.

The use of a strong acid solution permits reduction in the time necessary for treatment. However, it was not Mr. Croasdale's intention to recommend the use of 10 per cent acid in practice, but it was realized that some acid is consumed almost immediately by the lime and iron in the ore, as well as by the copper. Most of the iron compounds in the oxidized ore have resulted from the slow oxidation of pyrite; they are more in the nature of precipitated ferric hydroxide or ferric oxide than of hematite or of magnetite. Consequently, the iron passes into solution almost as readily as does the copper. This is not true in respect to the alumina, although the soluble alumina is the product of a kaolinization of the porphyry by the acid formed by the oxidation of the pyrite.

Tests were then carried out on a larger scale and more in conformity with operating conditions. A pipe was used, 10 in. diameter and 18½ ft. long. In the bottom of this was placed a screen on which a natural gravel "filter" was arranged. The conclusions reached after tests had been made on ore crushed to pass 4- and 2-mesh screens were: (1) That the height of column had no retarding effect on downward percolation, and (2) that upward submergence followed by downward percolation was indicated as desirable. Subsequent investigation and decision on the part of other research engineers were such that Mr. Croasdale's recommendation in regard to downward percolation was overruled; upward submergence, however, was adopted.

Experiments were then made on materials to be used for the construction of the leaching vats, and various acid-resisting substances were tried. Five experimental vats were equipped with different types of lining; in these about 300 tons of ore from test pits and shafts was treated, all of which passed a 2-mesh screen, except that used in one test. These experiments indicated that leaching was practicable; but in the test in which the ore had been crushed to pass a 4-mesh screen, the fine material in the charge interfered so much with lixiviation and washing that a low extraction resulted. The average rate of percolation is given as 78 in. per hour. Mr. Croasdale favored precipitation on iron, being of the opinion that electrical precipitation, using insoluble anodes, had not been proved successful on a commercial scale. He contended that the recovery of acid during electrolytic precipitation at Ajo could never develop into an important item, because of the small percentage of copper precipitated from the solution during each passage through the cells and the relatively large amount of acid consumed by the iron, lime, and alumina. It was recognized that the stronger solutions only are amenable to electrolytic precipitation; anyway, such a method amounts to little more than a skimming process, although in the aggregate a large amount of copper is recovered, and in a refined condition.

Production of Sponge Iron Practicable

Mr. Croasdale considered various kinds of sponge and pig iron as a precipitant, but the experiments were not concluded by the time a decision was made to adopt electrolytic precipitation. However, a quantity of information had been obtained concerning the production of sponge iron, which Mr. Croasdale still considers can be made easily and cheaply from hot calcine or from other sources. At the time of the experiments at Douglas the intention was to consider the utilization of the calcine from the roasting furnaces in the acid-making plant. It was found an easy matter to produce the sponge iron by an intermittent process, but this was not considered desirable. In this connection it is interesting to note that the Chino Copper Co. is reported to have developed an efficient and economical process for making sponge iron from the magnetite extracted from tailing. It is probable that the use of such a precipitant will attract further attention when a satisfactory method of continuous manufacture is perfected.

Rate of Percolation

The conclusions reached as to a desirable rate of percolation are of interest. To have attained the velocity reported in some of the tests indicates washing rather than percolation; and even if the material were thoroughly mixed and evenly distributed in the vat it is difficult to conceive how the equilibrium of distribution of fine and coarse could be maintained with such a rapid flow of liquor. This view is supported by the circumstance that trouble resulted when 4-mesh material was used in one of the tests, for it is difficult to understand why ore of such a character and fineness should not leach satisfactorily at a normal rate of flow. The small-scale tests made at Douglas were performed on material that was crushed in an unsuitable machine, and it is probable that a large amount of fine was produced. However, the practice of ultra-rapid percolation was adopted in all subsequent experimental work and ultimately also when the full-sized plant was put in operation. It is obvious, therefore, that the advantages resulting are more than sufficient to compensate for any possible disturbance of the equilibrium of the charge, and movement of slime in the direction of percolation.

Notable Results of Croasdale's Research

The experimental work done by Mr. Croasdale at Douglas resulted in a tailing that averaged 0.32 per cent from an ore that contained 1.43 per cent copper. The depth of column utilized was about 12 ft. The trail leading to successful accomplishment had been blazed—Mr. Croasdale was complimented by Dr. Ricketts in the *Transactions* of the Institute for having "ably conducted a long series of most valuable experiments"—and the scene of action was moved to the mine. In the meantime, F. L. Antisell, the superintendent of the Raritan Copper Works, had sent Andrew D. Jamieson to Douglas to supervise the construction of a test plant and to control its operation according to plans devised by Mr. Antisell. The proposed process, in brief, consisted of crushing the ore to pass a 3- or 4-mesh screen, upward percolation with a solvent consisting of dilute sulphuric acid, electrolytic deposition of the copper in the solution, reduction of the excess of ferric iron by sulphur dioxide, and the use of a special anode that had been developed and patented by Mr. Antisell. Except for the substitution of lead for the patent anode, this process is remarkably similar to the one that was adopted ultimately by the New Cornelia company. Tests had been made with the Antisell patent anode at Douglas between January and August, 1914.

Pope-Hahn Leaching Process

Still another process attracted attention about that time, having been developed by Dr. Frederic Pope and Albert W. Hahn, both of whom went to Douglas in April, 1914, then to Ajo in August, remaining there until the latter part of the year. The Pope-Hahn process, as it was called, possessed several distinctive and attractive features. The ore was leached with two solutions. The first effluent, carrying but a small amount of impurity, was sent direct to the electrolytic cells, the second being neutralized with roasted concentrate and agitated with air and steam. The pulp was then filtered, and this solution joined the first effluent, going also to the electrolytic cells. The idea apparently originated from the process of Ottoker Hoffman, in which a solution containing iron, alumina, arsenic, and antimony may be freed of its impurities by the addition of some form of copper oxide. The Pope-Hahn adaptation of this process was sound, both in theory and in practice.

The experimental work at Ajo was continued by Henry A. Tobelmann, James A. Potter, Andrew D. Jameson, and J. S. Olmstead, all of whom went there from Douglas in July and August, 1914. The results obtained during this period have been condensed from a joint paper[5] by Dr. H. W. Morse, research engineer for the Western Precipitation Co., who went to Ajo in August, 1915, and by Mr. Toblemann, afterward metallurgist for the New Cornelia company.

Mr. Croasdale's conclusions on leaching with dilute sulphuric acid were taken as the basis for further experimental work of a similar nature. His conclusion in

[5] *Trans.* A. I. M. E., 1916, p. 380.

regard to fouling—that the amount of deleterious substances taken into solution was small—suggested the possibility of a closed leaching cycle with electric deposition, and a regeneration of some of the acid required. Iron, dissolved from the ore and oxidized during electrolysis, was recognized as constituting a troublesome factor that might militate against the successful adoption of electrical precipitation. Three remedies were considered: (1) The use of a diaphragm; (2) the use of a depolarizer; and (3) the purification of the liquors before electrolysis.

Enlarging the Experimental Plant at Ajo

The tests at Ajo soon confirmed Mr. Croasdale's results as to the economic practicability of leaching with dilute sulphuric acid, but further investigation was needed to determine the precise degree of crushing advisable, and also the amount of fouling that might take place in the solution after repeated use. The construction of an additional experimental plant, of forty-ton unit capacity, was finished in February, 1915, and this was operated concurrently with the one-ton unit plant.

The problem of fouling became more insistent as the work proceeded, the ferric content of the solution rising to such an extent that the efficiency of electrolytic deposition became undesirably low. With the coming of cool weather the pipes in the plant became clogged with deposits of crystals of iron-copper sulphate. To remedy this Mr. Tobelmann suggested that a proportion of nearly neutral solution be isolated from circulation, passed over scrap iron to produce cement copper, and then returned to the main circuit. This innovation proved to be practicable; it solved the difficulty and was adopted, the ferric iron being reduced to the ferrous state and the copper being dissolved again in pregnant solution high in ferric iron, the resultant liquor being then returned to the electrolytic circuit. This feature was, perhaps, the most important development during this phase of the investigations. The remedy was simple; it provided a cheap method of avoiding fouling. It was arranged that the bulk of the solution from the leaching plant should go to reduction towers, where it would meet sulphur dioxide to be produced during the roasting of pyritic ore in mechanical furnaces, and by which it was expected that the amount of ferric iron in the solution would be lowered to less than 0.4 per cent.

Crushing the Ore for the Experimental Plant

The earlier tests at Douglas were made on ore that had been passed through rolls. The final tests at Ajo were made on ore that was first crushed in a Blake breaker from 10 to 4 in., then passed through a 48-in. Symons horizontal disk crusher to reduce it to 1½ in., and lastly through a vertical disk crusher to reduce it to ⅜ in. The final product, according to the average of sizing tests on 290 head samples, representing 300 forty-two-ton charges, aggregating 12,000 tons, was as follows:

Mesh	Individual, Per Cent	Cumulative, Per Cent	Copper Per Cent
+ 3	9.7	9.7	1.16
4	21.0	30.7	1.17
6	20.0	50.7	1.18
8	14.1	64.8	1.19
10	8.0	72.8	1.24
14	6.0	78.8	1.28
20	4.2	83.0	1.37
—20	17.0	100.0	1.61
Totals and averages	100.0	....	1.40

Many mechanical problems had to be solved before making a final decision on a number of details. Exhaustive experimental work was performed so that no mistake would be made in the final choice of a material for anodes. Lead had given good results during one year's service, but it was realized that the use of graphite promised a higher efficiency per pound of copper deposited, as well as a greater regeneration of acid. However, a number of pertinent considerations militated against the adoption of graphite; it was found that control must be so exact as to make its use almost impracticable. Lead, on the other hand, provided a fool-proof material for the purpose, and it was recommended for final adoption.

After continuous research for nearly twelve months with the one-ton and forty-ton experimental units, during which time about 15,000 tons of ore had been treated and nearly 190,000 lb. of copper had been produced, a final report of recommendations was submitted in January, 1916, signed by H. W. Morse, H. A. Tobelmann, and J. A. Potter. The proposed plan of operations is outlined graphically in the accompanying flow sheet, taken from the Morse-Tobelmann paper[6] on the work of testing the ore.

A summarized statement of conclusions indicated that operation on a full scale, 5,000 tons per day, would result in an extraction of 82 to 83 per cent of the copper in a 1.4 per cent ore; that the consumption of sulphuric acid would amount to 3 lb. of pure acid per pound of copper, that the "bleeding" and purification of 1 per cent of the total solution was necessary to prevent fouling; that the power efficiency obtainable by using lead anodes would be 1 kw.-hr. per pound of cathode copper produced; and that the rate of circulation adopted in the test plant, which amounted to two gallons per minute per ton of ore, was undoubtedly much higher than was necessary.

To be continued

A New Antimony Ore Producer in Australia

Antimony ore from the Costerfield mine, in Victoria, is being used by the Antox Syndicate, Ltd., of Sydney, for the manufacture of oxide of antimony, according to the London *Times Trade Supplement*. The product is being marketed as a non-poisonous substitute for white lead, and complete success is claimed for it. The Costerfield mine is said to be one of the largest antimony mines in the world, with practically inexhaustible supplies. Gold also occurs in the ore in small quantities, and is extracted by a separate process.

Antimony oxide is volatilized from a suitable furnace and the vapor condensed in a series of cooling chambers. In the first, the heat is about 300 deg. F. After going through two more chambers, the fume passes to a baghouse, the temperature then being about 120 deg. F. Careful temperature control is necessary, the color of the product varying from a pure white to a dull orange shade, depending upon the temperature at which the process is conducted.

As a result of eight months of operation, the Antox Syndicate, Ltd., declares that the oxide can be manufactured cheaper in Australia than in Europe, largely owing to the development of a contrivance by which the oxide is withdrawn from the chutes.

[6] *Trans.*, A. I. M. E., 1916, p. 380.

CONSULTATION

The Identification of Carnotite and Radioactive Minerals

"I wish you would tell me, if you can, what the ore which is called carnotite looks like, or what family or group of minerals it belongs to. I have the platinum family of minerals here and I may have radium if I knew what to look for and how to test them."

Carnotite, according to Dana, belongs to the uranite group of minerals and has the approximate composition $K_2O.2U_2O_3.V_2O_5.3H_2O$, a compound containing potash, oxides of uranium and vanadium, and water. It is mined not only for its uranium and vanadium but also for the slight amount of radium which it contains. Carnotite has an earthy appearance, and is a canary to lemon yellow in color. It may occur as a powder or in masses, and is comparatively soft, its hardness being about equivalent to that of gypsum or talc. Large amounts of the mineral are mined in Colorado and Utah and shipped to reducing plants. We have never heard of the association of radium with platinum.

The prospector who thinks he has discovered radium-bearing minerals should send his samples to a competent laboratory, either government or privately owned, for a qualitative analysis. The detection of radium is a simple matter, although not readily performed in the field. One of the simplest means of determining whether a mineral is radioactive or not is to subject it to a test with an electroscope. Radioactive minerals have the power of discharging an electroscope, and under suitable conditions the rate of discharge is proportional to the amount of radioactive substance in the mineral. J. F. McClelland has described an electroscope used by engineers and prospectors to detect radioactivity and to make a quantitative test. He states that radium is obtained solely from uranium ores, the amount of radium bearing a constant relation to the amount of uranium present; normally one unit of uranium is accompanied by 3.3 x 10-7 units of radium—an infinitesimal amount. Thorium compounds and minerals also discharge the electroscope.

This simple electroscope was suggested by B. B. Boltwood, and can be made in the field from a five-cent piece, a quarter dollar, or an iron washer as a base, on which is placed a drop of sealing wax or candle grease to hold in an upright position a long wire nail or a piece of tin about $2\frac{3}{4}$ in. long, flattened at its upper extremity. One end of an aluminum leaf about 0.1 in. wide and $1\frac{7}{8}$ in. long is attached to the tip of the upright with mucilage or paste, and the apparatus is ready to be used. The bottom of the upright nail or wire must be insulated from the iron washer or quarter used as a base by the piece of sealing wax, and the wax must not be touched with the fingers after it is in place. If no aluminum leaf is available, a piece of tissue paper both sides of which have been covered with graphite by rubbing with a lead pencil will serve as a substitute. An inverted tumbler is used to protect the apparatus from air currents.

The electroscope is charged by touching the upright with a piece of hard rubber—a fountain pen will do—which has been electrified by rubbing on one's sleeve. A protractor placed behind the electroscope enables the angle to be read between the leaf and the upright after charging, and the rate at which the electroscope will discharge itself by leakage can readily be ascertained. The mineral to be tested is placed inside the tumbler: radioactivity is proved by a rate of discharge faster than that due to natural leakage.

A series of tests made by H. G. Mead with this apparatus shows surprisingly accurate results on quantitative tests if handled carefully.

Aluminum leaf is much more satisfactory than paper but requires greater skill and patience in manipulation. For quantitative work a small sample of ore of known uranium content is required to standardize the electroscope; unknown samples may then be tested. Much care must be taken to avoid salting the containers used. A portable electroscope with reading device is made by the Denver Fire Clay Co., of Denver, Col.

Wireless Telephone Apparatus

"I was much interested in your recent editorial on the wireless telephone and am anxious to learn where I can obtain the apparatus for receiving the broadcasting service which you describe."

Hundreds of places in New York and vicinity sell radio equipment, although we understand that certain parts are difficult to secure, on account of limited manufacturing facilities and excessive demand. Without doubt a great deal of apparatus sold is not suited to the buyer's needs, and for much of it unduly extravagant claims are made.

Before purchasing any equipment, you should familiarize yourself with some of the fundamentals of the science. To this end we would suggest a book recently issued by the U. S. Signal Corps, "The Principles Underlying Radio Communication," second edition, obtainable from the Superintendent of Documents, Washington, D. C., for $1. You might also subscribe to the *Radio Service Bulletin*, issued monthly by the Bureau of Navigation, Department of Commerce. The subscription price is 25c. per year, from the Superintendent of Documents, Washington. There are also several magazines devoted to radio communication, which carry the advertisements of a large number of dealers in wireless equipment. Among these are *Wireless Age*, a monthly, 326 Broadway, New York; price, $2.50 a year; *Radio News*, a monthly, 236 Fulton St., New York; price, $2; and *Q. S. T.*, a monthly, 1,045 Main St., Hartford, Conn.; price $2. There is also the bi-monthly *Proceedings* of the Institute of Radio Engineers, College of the City of New York, New York City, the subscription price of which is $9 per year. Harper Bros., New York, have recently published a book by Verrill which sells for 75c., which describes how to make a home-made receiving set.

THE PETROLEUM INDUSTRY

Freight-Rate Reductions Should Readjust Oil Industry in Southwest

Inequities of Former Transportation Charges Seriously Reduced Production and Resulted in Discrimination Against Interior Refineries

IN CONNECTION with its recent decision ordering a horizontal reduction in freight rates amounting to about 10 per cent, the Interstate Commerce Commission analizes the situation in the petroleum industry as follows:

In the United States 469,639,000 bbl. of crude oil was produced in 1921, an increase of 5.9 per cent over 1920, and 125,000,000 bbl. was imported from Mexico. The crude oil refined in 1921 aggregated 443,000,000 bbl., an increase of 2.2 per cent over 1920, and the total amount of gasoline, kerosene, fuel, gas, and lubricating oils shipped was 405,204,000 bbl., an increase of approximately 1 per cent.

Exhibits introduced by shippers indicated that the crude oil moved by rail in 1921 was 25 per cent less than in 1920, and that in 1921 only 6.6 per cent of the crude oil received at refineries came by rail, compared with 9.9 per cent in 1920. According to reports of carriers on file, the tons of crude oil originated on Class I carriers in 1920 were 6,435,074, and in 1921, 5,044,513 tons, or 22 per cent less. According to shippers, the number of carloads of petroleum products shipped by rail in 1921 was 735,000, or 8.5 per cent less than in 1920. The number of tons of petroleum products originated on Class I carriers as appearing in their reports was 29,615,954 in the year 1920, and 27,216,185 tons in 1921, a decrease of 8 per cent.

IMPORTANCE OF PETROLEUM PRODUCTS TO BASIC INDUSTRIES

Fuel oil, gasoline, and other petroleum products are important elements of cost in mining, agriculture, and industry, being used as fuel or motive power for mine machinery, irrigating plants, tractors, and trucks. Petroleum loads heavily, moves in large volume with little loss or damage, and shippers usually furnish the tank cars. They say that their compensation from the carriers for use of the cars is less than cost. The carriers pay at the same mileage rate on empty as on loaded cars, and the movement empty is practically 100 per cent of the loaded movement.

In August, 1918, at the solicitation of the petroleum industry, the Director General of Railroads substituted a flat increase of 4.5c per 100 pounds in all carload rates on petroleum and its products for the 25 per cent increase previously applied under his General Order No. 28. This resulted in comparatively small percentage increases in long-haul rates, but the percentage increases in short-haul rates were greater than on commodities generally and in many cases ranged from 100 to 200 per cent. Shippers stated that as a result most short-haul rates upon petroleum, especially upon crude and fuel oil, are greatly out of proportion to the cost of transportation.

Petroleum and its products are consumed generally throughout the country, but the greatest consumption is in the states east of the Mississippi and north of the Ohio and Potomac rivers. At one time most of the refineries were situated in the eastern group. In recent years many refineries have been constructed in the Southwest and at Atlantic Gulf and Pacific Coast points. In 1921 there were approximately 250 refineries in the Southwest, of which 130 were shut down. Less than 50 per cent of the total capacity of the interior Southwestern refineries was in operation during that year, but refineries on the Gulf Coast and east of the Mississippi River were operated at approximately 85 per cent of capacity. Some of the Southwestern refineries appear to be of inferior construction, but nothing of record indicates that, capacity considered, most of them are not as efficient in operation and equipment as refineries generally.

AUGUST, 1920, RATES A HEAVY HANDICAP

Shippers urged that the greater extent to which interior Southwestern refineries were idle in 1921 was due to the percentage increases in rail rates on petroleum products from these refineries to Northern and Eastern markets, which had widened the spread in transportation charges to the disadvantage of Southwestern refiners. For example, the rates from Tulsa, Okla., and Wood River, Ill., to Cleveland, Ohio, prior to the increase of 1920 were 45c. and 25c. respectively, a difference against Tulsa of 20c. That increase resulted in rates of 62c. and 35c. respectively, increasing the difference to 27c. The record indicates that although more than 55 per cent of the crude petroleum produced in the United States in 1921 came from wells in the Southwest, less than 20 per cent of the total crude produced was refined by the interior refineries in that region; and that, of the crude produced in the Southwest, 57 per cent moved either by pipe lines to refineries elsewhere, or by pipe lines and tank vessels to Atlantic ports, thus depriving the rail lines of much revenue. Shippers say that such readjustments as the carriers have made since August, 1920, instead of lessening the burden placed upon the Southwestern refineries by the percentage increases, have augmented that disadvantage to the extent of 3.5c. per 100 lb., the amount of a flat reduction in rates between points in central territory and from central to trunk-line territory. Following that reduction, the advantage of Wood River over Tulsa in reaching Cleveland became 30.5c.

Rail lines are not obtaining as great a proportion of the total movement as they did in former years. This is due chiefly to the rapid development and increased use of other forms of transportation, notably pipe lines, motor trucks, tank vessels, and accessorial storage facilities. While transportation by these other forms of carriage is undoubtedly in many instances

more economical than by rail, and while rail lines may not expect to retain the entire traffic, use of the other forms of transportation is enhanced by the existing level of rail rates. The increases in many short-haul rates over the 1917 basis are now from 5 to 6.5c. per 100 lb., which in themselves would be high rates in many cases. Many short-haul rates are materially higher than on other commodities of like transportation characteristics. The rail lines are losing some short-haul traffic which they might retain at lower but still remunerative rates. Self-interest would seem to dictate revision by them of their short-haul rates.

Shippers of petroleum throughout the country have agreed upon a plan contemplating reductions in and readjustments of practically all petroleum rates on the following basis:

1. In official classification territory: Readjustment to rates of Jan. 1, 1917, plus 40 per cent.
2. In New England: 4.5c. per 100 lb.
3. Between trunk-line territory and New England: 4.5c. per 100 lb., with 90 per cent of fifth class as a maximum.
4. Between central freight association territory and New England: Readjusted to basis of 2c. per 100 lb. over the New York rates (No. 1 above).
5. Southern and Western classification territories, except Pacific Coast: (1) Local rates—15 per cent, plus a specific reduction of 4.5c. per 100 lb. (2) Proportional rates—15 per cent, plus 2 or 2.5c. per 100 lb., whichever was authorized in freight rate authority No. 96.
6. Pacific Coast territory: 15 per cent, plus specific reductions of 4.5c. per 100 lb.
7. All territories: Application of any minimum rate for short hauls eliminated.

It is not necessary to discuss this plan in detail. Little specific information was presented relative to its effect upon existing rate structures or the revenues of the carriers. Evidently important changes in relationships and decrease in revenue would result from its adoption, unless accompanied by an increase in tonnage hardly to be anticipated. In official classification territory the reduction would be about 30 per cent and carry the rate level below that obtaining immediately prior to August, 1920. The rates could be made effective only by recomputing all existing rates and re-issuing the schedules. This would take much time.

The percentage increase of 1920, coupled with the subsequent reduction of 3.5c. in central territory, has tended to lessen the rail movement of refined products and fuel oil from Southwestern refineries to Northern and Eastern markets and to increase the movement of crude oil by pipe line from Southwestern producing territory to Northern refineries, and also to Gulf Coast refineries from which the movement is by water to North Atlantic ports and thence by short rail hauls into the interior. As a result the Southwestern refineries are suffering while other refineries are operating more nearly at capacity.

This situation appears to clearly fall within the class of readjustments contemplated when the increases of 1920 were authorized. Carriers should promptly revise their rates from the Southwest to the Eastern group in order to lessen the spread as compared with rates between points in central and trunk-line territories. This should not be construed as requiring re-establishment of the precise differences which existed immediately prior to the increases of 1920.

Only 25 per Cent of Russian Oil Production Can Be Exported

SPECIAL CORRESPONDENCE

Much international attention is being paid at present to the Russian oil industry, and the following data are therefore of general interest: Up to the outbreak of the war the production of mineral oil in Russia amounted to about 20 per cent of the world's production, and decreased in 1921 to 3.7 per cent. In spite of this, the oil production of Soviet Russia still occupies the third rank in the world. During the year 1920 the production amounted to 25,400,000 bbl., and in 1921 to 28,500,000 bbl. In the district of Baku the production in 1921 amounted to 155,000,000 poods (36 lb.), and during the year 1919 the production in this district amounted still to 215,000,000 poods and in 1920 to 175,000,000 poods. During the last two years named the oil fields were exploited by the British.

In the district of Grosny the monthly production during the second half of 1921 amounted to 6,100,000 poods, and in January, 1922, to 7,100,000 poods. On account of lack of bore material new borings cannot be made. The machinery in the refineries as well as the pipe lines are in bad condition. According to the regulations of the Soviet government adopted at the beginning of the present year, concerning the grant of mineral oil concessions, 30 per cent of the produced oil is reserved to the state and 45 per cent must be reserved for the home demand. Only 25 per cent can be exported, and all export orders must pass through the official mineral-oil office. Payments for export orders are to be effected by means of the State Bank or the oil office, and all payments are to be in foreign values.

Freeport Sulphur Co. Brings In New Well in Gulf Oil Fields

SPECIAL CORRESPONDENCE

The most recent development in the Gulf Coast oil field is the completion of a producing well at Stratton Ridge, Brazoria County, Tex., by the Freeport Sulphur Co. This well, the No. 9 Dannenbaum, is on the northeast side of the dome, and was drilled to a depth of 4,368 ft. The oil is coming from a stratum a little above this depth, and at the rate of 1,500 to 2,000 bbl. daily. This well will force drilling in adjoining leases held by the Texas, Humble Oil & Refining, Sun, Empire, and other companies. Stratton Ridge will be, apparently the next coastal oil field.

At High Island, in Galveston County, one of the most prominent, topographically, of the salt domes, a shallow cap-rock well, 155 ft. deep, has been drilled, and is now standing full of oil. Desultory drilling has been done here for many years, but hitherto without the discovery of oil in paying quantity. This well may point the way for further successful development work.

In two of the older producing salt-dome fields, wells have been brought in. At West Columbia, the Humble Oil & Refining Co.'s No. 1 Badge well was completed at 3,400 ft., making 4,000 bbl. of oil. This well is in what is now called the northwest extension of the field, and adds a large acreage of oil-bearing land to the field reserves. At Blue Ridge, Fort Bend County, the Kirby Petroleum Co.-Oil Producers' Association joint test No. 2 Blakely was recently completed at 4,001 ft., making 4,000 bbl. of light-gravity oil.

John Ballot

An Appreciation by Edward H. Nutter

IN AN EFFORT to characterize John Ballot as he was known to his friends, I wrote out a list of what seemed to me to be his principal attributes, with the idea of elaborating them. The bare list itself, however, presents a picture of him in somewhat rugged outline that may of itself be interesting. He was possessed to an unusual degree of a strong will, of great determination, of relentlessness in a fight, of honesty and integrity, of loyalty to his friends, associates and employees, of thorough-going patriotism, great kindliness, unusual generosity, a sense of humor, a far-seeing and penetrating mind, and a philosophic serenity of disposition. Perhaps his most salient characteristics, aside from his far-seeing and penetrating intelligence, were his determination and his kindliness.

John Ballot

John Ballot was born in Cape Colony, in British South Africa, in 1861. He died in New York on April 1, 1922, of a lingering illness due to heart disease. He was a man of strong scientific curiosity; he was among the first to appreciate the possibilities of the deep leads on the Rand, and wrote a paper pointing them out, which attracted much attention in the early days. The altitude of the Transvaal, however, was hard on his heart, and he removed to London about 1900. He became interested in the selective attraction of oil for certain minerals and began the investigation of processes involving this phenomenon. He purchased certain patents, optioned others, and financed thorough-going research investigations of this property of oil with a view to developing a commercial process. This research, which led up to the discovery of the froth flotation process as now known, he personally followed closely, and largely directed it. The steady purpose with which he pressed it through for a number of years and until success was obtained, and then the grim relentlessness with which he fought through the litigation in protection of his companies' rights, testify most eloquently to his will and to his determination. This litigation is so fresh in the public mind that it hardly needs recapitulation. Briefly, however, it was (1) the suit of the Elmores against Minerals Separation, Ltd., which was finally decided in favor of Minerals Separation, Ltd., by the House of Lords in England; (2) the suit of the Elmores against the Sulphide Corporation, a licensee of Minerals Separation, Ltd., which was finally decided in favor of Minerals Separation, Ltd., by the Privy Council, the "Supreme Court" of the British Empire; (3) the litigation in the United States, which has been twice through the Supreme Court, and has only recently been settled out of court. This American litigation lasted practically eleven years, and was directed throughout by Mr. Ballot and his associate and friend, Dr. Gregory.

To his employees and subordinates John Ballot was more like a father than an employer, and his loyalty to and consideration for them induced for the most part a corresponding loyalty to him and to his companies. This affection is perhaps best shown by the fact that in his will he remembered generously each member of the Mineral Separation staff. He was devoted to his wife, who survives him, and was in all his personal relations most kindly and lovable.

Mr. Ballot was a man of great acumen and intelligence, which is shown by the fact that the companies he was instrumental in building have survived the stress and turmoil of the last ten years and that without any so-called war profiteering. He had an unusual instinct for avoiding possible pitfalls or untenable positions, which his opponents abundantly learned months and years after he had foreseen and avoided them.

Many attempts were made after the United States had entered the war to utilize against the Minerals Separation companies the pre-war agency contract with a German metal firm, and it developed that Mr. Ballot, at an early stage of the war, had laid the complete situation before the British Board of Trade and that the Minerals Separation companies were working in close adherence to rules then laid down for them by the Board of Trade.

It was no small contribution, either, that Minerals Separation was responsible for by way of war effort. Hundreds of thousands of additional tons of war metals, such as copper, zinc, lead, and molybdenum, were produced by flotation at a time when civilization so sorely needed them. Had Mr. Ballot not started the investigations when he did that led up to the discovery of present-day flotation, the very least result would have been a delay in its development that would have substantially affected the fortunes of the Allies.

As all know, the flotation process itself which Mr. Ballot was so largely responsible for has proved to be one of the few revolutionary metallurgical processes that have been devised. The economies and savings resulting from its use can be estimated in terms of hundreds of millions of dollars.

Mr. Ballot was possessed of a quiet but keen sense of humor. One time he and I were lunching in the Dominion Hotel in Globe, Arizona. A torrential rain was falling in the street outside. It was before national prohibition, but after Arizona state prohibition was in force. He sat carefully drafting what I thought was a telegram. When he handed it to me it proved

to be a verse of clever doggerel contrasting his internal dryness with the outside wetness.

Mr. Ballot regretted that his years and health were such that it did not seem worth while for him to become an American citizen. He told me once that he had formerly had a wrong idea of the United States and its people, and that if he were a younger man he would like nothing better than to make his home in the West and help to build and develop it. The potentialities of the West, its resources and possibilities, which he clearly saw, and the character of its people, greatly attracted him. During the last few months of his life he hoped that he might recover his strength sufficiently to enable him to make the trip to California, where he had felt so invigorated by a previous visit.

Mr. Ballot was not a churchman, but he most profoundly respected the things of religion and the sincere religious convictions of others. The atheist's laugh found no response in him.

He was of Huguenot and English ancestry, and his earlier years were spent on the veldt, where he studied everything within his physical and mental vision from the stars to the rocks. After he had removed to London he soon made himself an important man in the City; and a life-long friend, J. H. Curle, who has traveled everywhere and knows nearly everybody, once told me that there was not a brain in the City of London that could be compared with John Ballot's. In a recent eulogy Mr. Curle wrote of him, "Where shall I find his like again?" Another friend, Alexander Gray, wrote "Such a rare nature can ill be spared"; while another friend wrote, "In John Ballot South Africa has lost another of her most brilliant and most sympathetic personalities, a man who in many ways will never be replaced."

It is no mean person who has moved his friends to say such things about him, and as time goes on it seems certain that John Ballot will be more and more recognized as one of the major figures that can be claimed by the mining industry.

Fluorspar Producers Improved Their Mines and Mills During 1921

During 1921 the concentrating mill of the Rosiclare Lead & Fluorspar Mining Co. at Rosiclare, Ill., was redesigned and rebuilt to improve mill practice. The additions include a large dewatering machine to dewater the mill feed and to separate the siliceous slime; a larger and more complete screening and sizing system, to assist the jigs in making cleaner separation; and tables to handle the fine sand spar, heretofore handled on jigs. Provision has also been made for handling spar middlings and re-treating them, to help keep down the tailing losses and to produce a better grade of gravel from the jigs. At the Eichorn mine, near Rosiclare, the shaft was sunk to a depth of 200 ft. and crosscuts were made to the vein at both the 100 and 200 levels. Drifts are being run at the 200 level, and some fluorspar has been taken out. Work upon a small milling plant has been started. Construction and development work at the Hillside mine and mill, near Rosiclare, was continued throughout the year, and it is expected that this modern plant will be put in operation at an early date. Exploration work was done at two openings on the property of the Spar Mountain Mining Co., near Cave-in-Rock.

The Ohio-Kentucky Fluorspar & Lead Corporation has recently taken over the Klondyke and Royal mines, near Smithland, Ky. It is reported that the Klondyke mine is now fully developed and has a 10-ft. vein at the 160 level, and that an up-to-date 100-ton mill is to be built during 1922. The shaft at the Royal mine, which has not been fully developed, is said to be about 400 ft. deep. A mill having a daily capacity of 250 tons is planned.

The new mill of the Great Eagle Fluorspar Co., in Grant County, N. M., was completed and put in operation during 1921, and a small quantity of ground fluorspar was shipped. Another new mill, that of the Ore Production Co., near Rincon, was also put in operation, and at the Tortuga mine of the Tortuga Fluorspar Co., near Mesilla Park, Dona Ana County, a jig has been added to the mill, which now has a capacity of fifteen tons of ground fluorspar every twenty-four hours. It is reported that a vein of fluorspar carrying 97 to 98 per cent of calcium fluoride was opened at the Tortuga mine.

According to the U. S. Geological Survey, authority for the above, reports from steel manufacturers who produce about two-thirds of the basic open-hearth steel made in the United States show that they consumed 46,341 tons of fluorspar in 1921, as compared with 80,545 tons in 1920. This group of steel manufacturers also reported stocks of fluorspar on hand Jan. 1, 1922, amounting to about 19,800 tons, as compared with 45,125 tons on Jan. 1, 1921. These reports therefore show that these steel plants consumed only 1,216 tons of fluorspar more than they had in stock at the beginning of 1921.

Back Beyond Methuselah

BY KIRBY THOMAS

Man's interest in the things which are in the earth must have begun early in human history. The Bible record on this subject is interesting. In the second chapter of Genesis reference is made to the "land of Havilah, where there is gold: there is also bdellium and the onyx stone." The philologists differ as to the meaning of the word "bdellium," some holding that it means balsam or resin, and others that it refers to a product from the earth, either a carbuncle (a precious gem) or crystal or pearl. Be this as it may, there are soon found other references to the point. In the fourth chapter of Genesis is the following: "And Zillah, she also bare Tubal-Cain, an instructor of every artificer in brass and iron." In the forty-fourth chapter is the passage: "and put my cup, the silver cup, . . . "

Jeremiah records in the seventeenth chapter: "The sin of Judah is written with a pen of iron and with a point of a diamond." Ezekiel says in the twenty-eighth chapter: "Thou hast been in Eden, the garden of God; every precious stone was thy covering, the sardius (cornelian), the topaz, and the diamond, the beryl, the onyx, and the jasper, the sapphire, the emerald, and the carbuncle, and gold." Ezra sets forth in the eighth chapter: "And twenty basons of gold, of a thousand drams, and two vessels of fine copper, precious as gold." Timothy, in chapter four, says: "Alexander the coppersmith did me much evil." In Genesis, the eleventh chapter, is found mention of still other earth products: "Go let us make brick and burn them thoroughly. And they had brick for stone and slime had they for mortar." In Deuteronomy reference is made to "a land whose stones are iron and out of whose hills thou mayest dig brass."

SOCIETIES, ADDRESSES, AND REPORTS

Engineering License Not Applicable to Mining Engineers

Committee on Registration So Decides At Council Meeting of F. A. E. S.

A council meeting of the Federation of American Engineers was held in Pittsburgh, May 26 and 27. Dean Cooley, president of the federation, in recounting the aims and ideals of the organization, said that despite the fact that engineers generally are idealists, have great public spirit, and perform inestimable public service, their work is not done in such a way that the people as a whole can recognize its origins.

Thirty societies are now supporting the federation, with individual members numbering about 60,000. The Canadian Institute of Engineers has taken steps to join, and much interest in the progress of the federation is being taken by societies on other continents.

One of the most important acts of the board was the adoption of the report of the committee on registration of engineers, of which Colonel Arthur S. Dwight, of New York, is chairman. The report as adopted contains the statement "that the reasons which justify the registration of engineers responsible for public work do not apply to mining engineers." It follows:

"In considering matters of government as affecting the engineering profession of the United States, the ancient principle which states 'that country is governed best which is governed least' has been accepted by your committee as representing ideal conditions, and it holds that in an ideal social organization, where man can be left free to follow the trend of his individual bent without resulting injury to his fellow, each should be free to follow such calling as he may adopt, without state interference or regulation.

"Engineering in the United States, under absolutely untrammeled conditions in the past, has developed effective skill and a high degree of constructive ability among its practitioners, during which period the provisions for safety have been adequate under average conditions, and the failures which may have occurred have not been rated serious enough to demand legal control. Within the past few years, however, a widely supported movement had appeared, resulting in the passage of laws, requiring licensing or registration of engineers in various states, and attempts at similar legislation in others. It is, therefore, a condition and not a theory which is before the engineering profession for consideration, and the F. A. E. S. should decide whether it will lend the weight of its advice upon principle only or will accept and travel with tendencies.

"The registration or licensing of engineers, with consequent elimination from practice of all not registered, can be supported upon only two grounds: (a) the benefit of the profession; (b) the good of the public.

"Your committee has grave doubts whether licensing can benefit the profession enough to justify the cost and annoyance of the proposed measure. Further, your committee holds it should be beneath the dignity of engineers to fence themselves against qualified competition by the artificial barrier of a statute.

"Your committee, while recognizing that required registration might not have been recommended *ab initio*, believe that the plan has now reached such development as to deserve consideration and possible direction by the F. A. E. S. (or A. E. C.)

"Therefore, your committee recommends to the A. E. C. (F. A. E. S.) an expression of opinion that such legislation may properly cover engineers and architects charged with responsibility for public works. Your committee is agreed that the reasons which justify the registration of engineers responsible for public works do not apply to mining engineers. Your committee is unable to agree as to the wisdom or unwisdom or registration of engineers engaged in other classes of work. Registration laws should provide reciprocity of registration admitting to practice engineers registered in other states and should further provide for the admission to practice of properly accredited engineers from states having no registration laws.

"Registration laws should provide for classified registration, that the certificate may indicate those branches of engineering in which the registrant is qualified to practice."

In adopting the report of its committee on public affairs, headed by J. Parke Channing, of New York, the executive board of the council determined, in the event of the failure of the President's efforts to bring about greater economy and efficiency in national affairs by a regrouping of Federal functions, to press independently a nation-wide movement for establishing a Department of Public Works.

Mine Signaling Discussed by Electrical Engineers

The Utah Section of the American Institute of Electrical Engineers held a meeting on May 26 at the Salt Lake City Commercial Club. A paper on "Mine Signaling" was read by Abner R. Wilson, electrical engineer at the Utah Apex mine.

Institute of Metals Meets With Foundrymen's Association

The Institute of Metals Division of the A. I. M. E. held a joint meeting with the American Foundrymen's Association at Rochester, N. Y., June 5 to 9.

SOCIETY MEETINGS ANNOUNCED

A Western mining conference of the **American Mining Congress** will be held at Denver, Col., on June 20 and 21. The discussion will be devoted exclusively to problems which confront the Western mining industry.

The annual convention of the **National Lime Association** will be held June 14 to 16, at Hotel Statler, Cleveland, Ohio. The activities of this convention will deal with the technology of the uses of lime and the industrial problems of manufacturing and marketing lime.

The **International Mining Convention** will be held at Nelson, B. C., July 3-7. S. S. Fowler, of Riondel, will preside, and Lieutenant Governor W. C. Nichol will formally open the convention. An address is to be given by T. A. Rickard, of the *Engineering and Mining Journal-Press*, on "English Speaking People." The Hon. William Sloan, Minister of Mines, will speak on "British Columbia's Mineral Resources and Industrial progress."

OBITUARY

George Lincoln Heath died at Houghton, Mich., May 27. Mr. Heath was graduated from the Massachusetts Institute of Technology in 1888. For thirty years he was chief chemist of the Calumet & Hecla Mining Co., at Hubbell, Mich. Since last September he has been connected with the chemistry department of the Michigan College of Mines. He was a fellow of several scientific societies and in 1916 published "The Anaylsis of Copper, Its Ores and Alloys."

William R. Cox, associated for over ten years with the Mason Valley Mines Co., of Nevada, died from heart failure at San Francisco on May 23. He was born at Cape Breton, Nova Scotia, Canada, in 1864. He came to the United States in 1883, working for three years in Montana. In 1896 he went to South Africa as a member of the staff of the Simmer Deep. After three years on the Rand he went to Western Australia, afterward returning to Africa. Since 1910 he had been in the United States, in Arizona and Nevada.

MEN YOU SHOULD KNOW ABOUT

S. J. Kidder, of Mogollon, N. M., was recently in San Francisco.

E. C. Warrener, of New York, has been visiting Cobalt and Kirkland.

N. E. Dowell is at Woodbury, Conn., doing field work in ground-water geology.

R. S. Knappen is engaged in oil and gas work in the Big Horn Basin, Wyoming.

E. H. Mott is now general foreman of the U. S. Metals Refining Co., at Chrome, N. J.

Thomas Riggs, former Governor of Alaska, is in Porcupine, after visiting Cobalt and Kirkland.

Edwin E. Chase, of Denver, is making mine examinations in the White Hills district of Arizona.

Dr. John H. Finley delivered the Class Day address at the Michigan College of Mines on June 9.

George H. Garrey has returned to Tonopah from a several weeks' examination trip in California.

F. H. Moffit sailed from Seattle on June 7 to make geologic surveys in the Chitina region of Alaska.

J. A. Carpenter has been appointed superintendent of the Randsburg Silver Mining Co., Randsburg, Cal.

Karl C. Parrish, mining engineer of Barranquilla, Colombia, is in New York for a visit of several weeks.

A. E. Fath, on leave of absence from the U. S. Geological Survey for several months, has sailed for Europe.

O. C. Ralston, of the U. S. Bureau of Mines, has returned to Berkeley from Arizona and the Eastern states.

Samuel W. Cohen has returned to Montreal after a four months' trip to California and other Western states.

M. R. Campbell left Washington June 2 for Wyoming, where he will examine coal claims for the land classification board.

Noah A. Timmis, president of the Hollinger Consolidated, of Porcupine, will soon visit the Elbow Lake, Manitoba, mining camp.

William G. Mather, president, and **S. Livingstone Mather**, secretary, of the Cleveland-Cliffs Iron Co., spent the week on the Marquette Range.

A. F. Buddington is sailing from Seattle on June 10 to investigate the mineral deposits of the Wrangell district of southeastern Alaska.

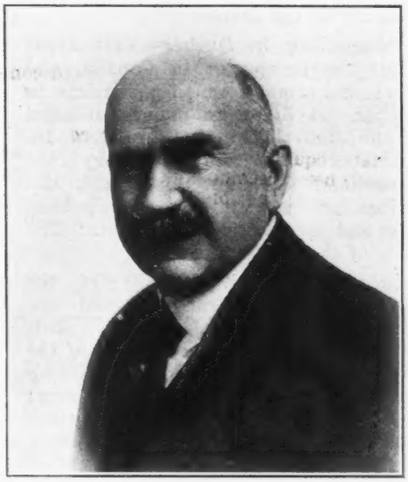
H. J. Evans, recently engineer on the staff of the Oriental Consolidated Mining Co., has arrived in San Francisco from Unsankinko, Korea.

Major Julius M. Cohen, of Montreal, consulting engineer of the Elbow Lake Mining Corporation, has gone to Elbow Lake to inspect the company's property.

J. P. Bickell, president of the McIntyre-Porcupine Mines, Ltd., is at the Blue Diamond coal mines, in Alberta, in which the McIntyre holds a half interest.

T. W. Vaughan lectured recently to the Naval Medical School of Washington on "The Study of Earth Science; Its Objects and Interrelations with Medicine."

E. P. Mathewson has been invested with the Third Order of the Rising Sun by the Japanese government. This was given Mr. Mathewson in recognition of his services in helping the developing of



E. P. Mathewson

the mining industry of Japan. He has also been elected honorary member of the Mining Institute of Japan. Mr. Mathewson sailed for England June 6 on the Mauretania for a month's trip in connection with his recent visit to the Burma Corporation, in India.

Dr. S. C. Lund, superintendent of the rare and precious metals station of the U. S. Bureau of Mines, in Reno, has returned to Reno from a two months' trip through Eastern states.

Harry C. Dudley, president of the Ahumada Lead Co., has returned to Duluth after several months in the Southwest and Mexico on business relative to his mining properties.

N. H. Emmons, 2d, has just returned from Mexico, where he has been for the last six months on professional business. He visited mines in the states of Jalisco and Oaxaca.

Frank W. Davis, of Philadelphia, has been engaged by the U. S. Bureau of Mines as a metallurgist at its Minneapolis station. He will begin work on ferrous metallurgy on July 1.

E. C. Vigeon, managing director of the Bede Metal & Chemical Co., Ltd., at Hebburn-on-Tyne, England, is making a visit to this country. He will spend most of his time in the Western states.

J. E. Tiffany, an explosives engineer on the staff of the U. S. Bureau of Mines, has returned from an official visit to England, where he has been studying processes and results at the British explosive testing stations.

John C. Metcalf has been promoted to the position of chief mining engineer for Pickands, Mather & Co., filling the vacancy created by the promotion of **W. A. Rose**. Mr. Metcalf will make his headquarters in Duluth.

Dr. F. W. McNair, president of the Michigan College of Mines, was in New York last week attending a meeting of representatives of the Society for the Promotion of Engineering Education and the National Industrial Conference Board.

O. B. Smith, formerly superintendent of Granby operations, has just completed an exhaustive examination of the placer deposits in the Lillooet section, in British Columbia.

H. W. Edmundson has completed the installation of the new mill for the Asbestos Corporation of America at Eden, Vt. Mr. Edmundson leaves for Oatman, Ariz., to report on the Leland and Vivian groups of mines for the Vivian Mining Co., of Los Angeles.

Frank Corwin has just returned to Humboldt after a ten-month vacation, during which time he covered fifteen thousand miles by automobile and visited practically all of the mining districts of interest in the West. Mr. Corwin is now connected with the Consolidated Arizona Smelting Co.

E. C. Bowers, superintendent of the Wickwire Mining Co.'s mines on the Menominee iron range, has been advanced to the position of general superintendent of the Wickwire-Spencer Mining Corporation, with headquarters in Worcester, Mass., and will take up his new duties at an early date.

W. J. Loring, now in Washington, has been elected president and managing director of the Carson Hill Gold Mines and related enterprises. **Archie Stevenot** has been appointed general manager of the Carson Hill Gold Mines and Chapparral Hill group recently acquired by the Loring interests.

C. A. Bennett, general superintendent of the Rochester Silver Corporation, is leaving Rochester for Candelaria to become superintendent for the Candelaria Mines Co. **Ellsworth Bennett**, who has been in charge of the Tonopah School of Mines for several years, will succeed his brother as superintendent of the Rochester Silver Corporation.

Dean Thomson of the Idaho State School of Mines, accompanied by **Keith Horning**, president of the Associated Miners of the State University, was in the Coeur d' Alenes and other northern sections of Idaho during the latter part of May. Mr. Thomson was accompanied by a number of mining students from the university, and many underground inspections were made.

Mining and metallurgical engineers visiting New York City last week included: **A. C. Langdon**, of Palouse, Wash.; **J. B. Rhodes**, of Philadelphia, Pa.; and **A. T. Ward**, of Havana, Cuba.

Technical Papers

Rock Drill Sharpening—The May *Bulletin* of the Canadian Institute of Mining and Metallurgy (Room 603-604 Drummond Building, Montreal, Canada; price, 50c.) contains an article "Rock Drill, Bit, and Heel Sharpening at the Murray Mine," by E. Hibbert. This paper includes a number of sketches and descriptive matter relative to the development of the bit that will be subsequently used, although the Murray mine is at present closed down. The sharpeners and furnaces that have been installed, and also the general arrangement of the various devices, are described.

Mining Industry of Idaho—Stewart Campbell, State Inspector of Mines of Idaho, has recently issued the twenty-third annual report of his department. This is essentially a directory of the mining companies having property within the state, 117 pages of the 154 in the report being devoted to a comprehensive list of this nature. The companies are classified by counties. An additional feature is a bibliography of the literature descriptive of the geology and mineral resources of each county. The report may be obtained from the Inspector of Mines, Boise, Idaho, on request.

Ontario Gold Deposits—Part 2 of the thirtieth annual report of the Ontario Department of Mines, Toronto, (free on request) is entitled "Ontario Gold Deposits, Their Character, Distribution, and Productiveness." The book does not contain detailed descriptions of the various properties, but gives a few words about almost every prospect and mine and describes general types of deposits, together with sketch maps of the various districts.

Fatigue of Metals—Publication No. 4 of the Engineering Foundation of United Engineering Societies, 29 West 39th St., New York City, contains a fifty-seven page paper describing research work carried on at the engineering experiment station of the University of Illinois on the fatigue of metals.

Mine Timber Preservation — In a paper, "The Preservative Treatment of Mine Timber," presented before the South African Institution of Engineers (appearing in the March, 1922, issue of the *Journal of the South African Institution of Engineers*, P. O. Box 4609, Johannesburg, S. A.; price, 2s.), L. D. Hingle reviews the various methods of wood treatment, the preservatives used, and the general results obtained. He also outlines practices adopted at the Rose Deep, Ltd., and the Consolidated Main Reef mines, on the Witwatersrand, where waste zinc sulphate liquor was used in preserving the timber. At the latter property, sodium chloride was added to the preserving bath, but this was found unnecessary.

Minnesota Mines — The "Mining Directory of Minnesota for 1922" has been issued by the Minnesota School of Mines Experiment Station, Minneapolis, Minn. It is a book of 156 pages, of handy pocket size, and is divided into four parts: Part 1 contains thirteen maps of the various mining districts; Part 2 a list of all mining properties that have shipped ore or are listed on the tax records as containing ore; Part 3 a list of the various mining companies that are identified with the iron ranges; also a list of officials, subsidiary companies, and the properties in which they are interested; and Part 4 a partial list of men associated with the mining industry of the state.

Prospecting in Quebec—Vast areas await the prospector in Canada, and there are some promising districts in Quebec. A five-page paper published in the *Bulletin* of the Canadian Institute of Mining and Metallurgy (603 Drummond Building, Montreal), describes briefly what has recently been done and suggests likely districts. The price of the separate is 25c.

Gold Metallurgy — Details of the treatment of a refractory gold ore mined at Prestea Block A, Gold Coast, Africa, are given in the *Journal of the Chemical, Metallurgical, and Mining Society of South Africa* (Johannesburg; price, 3s. 6d.). The paper describes practice existing during 1914 and 1915. The gold occurs both free and associated with refractory sulphides containing arsenic, antimony, and zinc. Carbonaceous schist is also present. The flow sheet described includes stamping, regrinding in pans, plate amalgamation, table concentration, roasting, and cyanide and sulphide treatment.

Osmiridium — In the journal mentioned in the previous note is also a short article of interest to chemists on the manipulation of osmiridium concentrate. Osmium and ruthenium offer difficulties in assaying as well as emitting dangerous fumes.

Germany and Russia—Those who are interested in economic trends and the condition of business in Germany and Russia will find a recent bulletin of the Chase National Bank, of New York, worth perusing. It is entitled "Germany and Russia—A Chapter of Uncertainties." The bulletin is of forty pages, and may be obtained on request to the bank mentioned.

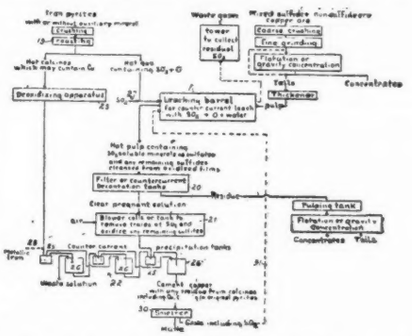
New Mexican Geology—Bulletin 726-E of the U. S. Geological Survey, Washington, D. C. (102 pages; free on request) is entitled "Geologic Structure of Parts of New Mexico." The bulletin has been prepared as a guide to the geologist in search of new oil fields.

Nickel-Copper Deposits—The *Canadian Mining Journal* for May 5, (Gardenvale, Que., price, 15c.) contains a two-page article descriptive of the Shebandowan nickel-copper deposits in western Ontario. The minerals are essentially pyrite, pyrrhotite, and chalcopyrite, and the deposits are thought to have economic possibilities.

Recent Patents

Flotation of Gold Ore—English patent No. 175,384, Nov. 11, 1920. H. L. Sulman, and Minerals Separation, Ltd. According to an abstract published in the *Journal* of the Society of Chemical Industry, crushed gold-bearing ore is treated by a known froth flotation process, preferably in a neutral or alkaline condition and using a tar oil containing phenol or cresol. A second separation is effected after precipitating a mineral compound (ferrous sulphide) in the pulp. Gold is separated with pyrites, and the recovery of pyrites may be taken as an index of the recovery of gold. The concentrate is treated subsequently by the usual cyanide process.

Sulphur-Dioxide Leaching—No. 1,410,936. E. S. Leaver and C. E. van Barneveld, Tucson, Ariz. A pulp containing a non-sulphide ore and water is



subjected to hot sulphur dioxide and oxygen, producing metallic sulphate in solution. The metal is then precipitated and separated as is indicated in the accompanying flow-sheet.

Pulverized Coal for Blast Furnaces—No. 1,411,072. R. A. Wagstaff, Salt Lake City, Utah, assignor to American Smelting & Refining Co., New York. A solid stream of pulverized coal is mixed with air in a special device designed to introduce the mixture into a blast-furnace tuyère to the best advantage.

Magnetic Ore Separator—Canadian patent No. 217,084. H. W. Arnold, Vancouver, Wash. A water-proof drum inclosing a plurality of magnets for removing magnetic material from ore pulp. The drum revolves in a trough, into which the pulp enters, and means are provided for removing he non-magnetic tailing as well as the magnetic material from the face of the drum.

Electrolytic Nickel—Canadian patent No. 217,914. N. V. Hybinette, Christiania, Norway. The patent covers the use of a filtering diaphragm which depletes the solution in the cathode compartment, of acid ions. The electrolyte is fed to the cathode compartment and removed from the vicinity of the anode. Particulars of the use of the equipment in depositing nickel are given.

THE MINING NEWS

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Leading Events

SUIT for $500,000 has been brought by the Kennedy Mining & Milling Co. against the Argonaut Mining Co., its neighbor at Jackson, Cal., for damages resulting from the fire in the latter's property three years ago. The Argonaut company has filed a counter suit for $800,000 for damages caused by the flooding of its workings, which it attributes to the Kennedy's carelessness.

Merger of the Coniagas Reduction Co. with the Electric Gas Bleaching Co., of Niagara Falls, is being planned. The latter is said to have a cheap and efficient process for treating cobalt ores.

Plans for the consolidation of the Republic, Midvale, and Inland steel companies as the North American Steel Co. have been divulged.

In Guanajuato, a law has been passed permitting the state to take over a mine or factory if shut down because of a strike.

Smelting has been resumed by the International Smelting Co. at Tooele, Utah.

Coniagas Reduction Co. To Merge With Niagara Falls Company

Latter Has Developed Cheap Process for Treating Cobalt Ores—Chemicals Also Will Be Produced

It is understood that the Coniagas Reduction Co., of Ontario, is to be amalgamated with the Electric Gas Bleaching Co., of Niagara Falls. The Coniagas plant was built at Thorold to treat high-grade cobalt ores, but the collapse of the market for cobalt metal resulted in the plant being shut down, with large stocks of cobalt residues and speiss on hand. Still further supplies are being accumulated from the residues after the treatment of ores from the Coniagas mine.

The process for the production of cobalt metal and oxides was both complicated and expensive, but it is understood that the Electric Gas Bleaching Co. has evolved a simple and inexpensive method with the use of fluorine gas. If the companies are amalgamated, one will have the supplies of raw material and the other the process for treating them. In addition to cobalt metal and oxides, caustic soda, chlorine gas, and liquid chlorine will be produced.

Consolidated Mining & Smelting Will Build 1,000-Ton Mill

The Consolidated Mining & Smelting Co. of Canada, of British Columbia, has definitely announced its intention to build a 1,000-ton mill at its Sullivan mine. The cost is estimated at $1,500,000, and the plant is to be completed next year. The mill now in use at Trail, B. C., will handle the ore from the Rossland mines of the company. The works office of the company is at Trail. Its head office is 1202 C. P. R. Building, Toronto.

Guanajuato Law Permits State to Take Over Mine in Case of Strike

Some Companies May Close If New Measure Is Enforced

The Legislature of the State of Guanajuato, Mexico, has passed a law giving the governor power to take over any factory, ranch or mine, wherein the owner or owners attempt to close the same, in the event of a strike or other disagreement with the employees. This law has been put in effect in lieu of provisions under the articles of the Constitution enabling Committees of Arbitration to enforce their edicts. Laws that are similar now obtain in the states of Vera Cruz, Puebla and Michoacan, and an attempt is being made by the governor of Chihuahua to put one through. Mining companies operating in these jurisdictions look upon the legislation as threatening the life of their operations, and a number of important concerns claim they will be obliged to close if an attempt is made to enforce the new laws.

Representations have been made to the Federal authorities in Mexico City that this legislation is in violation of their pre-guaranteed rights, as well as opposed to common sense and the spirit of reform which the authorities desire to enforce.

Democrata Plant Burned

At Cananea, Sonora, the power house and warehouse of the Democrata Mining Co. was destroyed by fire on May 24, with damage of $250,000. The Democrata's property is close to Ronquillo, the Greene-Cananea smelter town, and is almost surrounded by its larger neighbor.

New Merger of Steel Companies Planned

Includes Republic, Midvale and Inland —All Terms Not Disclosed, It Is Charged

Plans for the consolidation of the Republic Iron & Steel Co., the Midvale Steel & Ordnance Co. and the Inland Steel Co. were announced on June 1. The Midvale company will take over the other two and will probably change its name to the North American Steel Co.

The terms of the plan are as follows:

"All existing obligations of the three companies are to be assumed by the unified company. Existing preferred and common stocks will be changed into preferred and common stocks of the unified company. The new preferred stock is to have a par value of $100 per share, is to be 7 per cent cumulative, and is to be redeemable at $115 per share and accrued dividends, and is to be convertible for twelve years into new common stock at the rate of five shares of new common for four shares of new preferred. The common stock is to be without par value.

"All assets of the three companies are to be owned by the unified company, except the Nicetown plant (the armor-making, ordnance and forging plant) of the Midvale Steel Co., which is to be transferred to a separate company with a capital of 500,000 shares without par value.

"Participation in the new stock will be as follows:

"Under the plan Midvale company stockholders are to receive 75 per cent in new common stock and 25 per cent in stock of the company formed to take over the Nicetown plant.

"Republic Iron & Steel preferred stockholders are to receive dividends in cash up to the date when the new preferred dividend begins to accrue, and 100 per cent in new preferred stock.

"Republic Iron & Steel common stockholders are to receive 170 per cent in new common stock.

"Inland company stockholders are to receive 25 per cent in new preferred stock, which is to be purchased from them at $95 per share, and 70 per cent in new common stock.

"It is intended to provide $20,000,000 additional cash working capital by the sale of common stock.

"Negotiations are pending for the acquisition of other properties, but, irrespective of the outcome of these negotiations, Midvale, Republic Iron & Steel, and Inland propose to proceed with the plan.

"Messrs. Kuhn, Loeb & Co. have agreed to act as bankers for the plan."

In addition to these terms, it is said that there are secret clauses in the agreement, by one of which Kuhn, Loeb & Co. was to be permitted to raise up to $20,000,000 "to make a market" for the stock of the new company.

International Starts Smelter at Tooele, Utah

Operations were resumed by the International Smelting Co., at Tooele, Utah, on June 1. The company is a subsidiary of the Anaconda Copper Mining Co. For some time it has been gathering and stockpiling ores. Contracts have been made for ore from most of the western mining districts. The Walker Copper Co., at Portola, Cal., which is controlled by the Anaconda company, is expected to furnish a large part of the copper ores, and a better rate has been made with the Western Pacific R.R. on ores from its property. Ores from the Utah Consolidated, at Bingham, and from the Vipont Silver Mining in Box Elder County, will also go to Tooele; likewise ores from the Judge and Park-Utah properties at Park City.

Dredging Plant Ordered for Work at Nome

W. P. Hammon and others have made an arrangement with the Pioneer Mining & Ditch Co., formerly the Pioneer Mining Co., to work dredging ground at Nome, Alaska, according to word from San Francisco. Contracts have been let by the Hammon interests to the Yuba Manufacturing Co. for the construction of two nine-cu.ft. dredges and a 1,200-hp. plant, all to be in operation in the summer of 1923.

Yukon Gold Co. Completing Dredges

The Yukon Gold Co. is exporting from San Francisco and New York machinery to complete tin dredges Malay No. 2 and 4 in the Federated Malay States.

Kennedy Company Sues Argonaut for Damage from Fire

Asks $500,000—Defendant Files Counter Suit for $800,000

Suit for $500,000 damages was filed May 27 by the Kennedy Mining & Milling Co. against the Argonaut Mining Co. Both companies have adjoining properties near Jackson, Cal., and are among the largest gold-mining companies in the West. Fire started underground in the Argonaut on March 27, 1919. The mine was sealed and the fire thought to be extinguished by the use of carbon dioxide gas, which was forced into the mine on April 3, 1919. The mine was reopened on April 12, and the fire broke out again on April 13. It was then bulkheaded, but later it was found necessary to flood both the Argonaut and Kennedy. Flooding of the mines started March 15, 1920. In May, 1921, both mines were unwatered, and were reopened last fall.

The owners of the Kennedy property contend that the fire in their property was the result of the destruction of a barrier wall between the two mines and that no attempt was made to check the progress of the fire into the Kennedy. W. E. Colby and John Partridge are the attorneys for the Kennedy.

The Argonaut Mining Co. has filed a counter suit against the Kennedy, asking for $800,000 damages. The Argonaut alleges that the Kennedy carelessly handled the fire and flooded both mines, causing the Argonaut to be shut down for more than a year.

Mill for Clifton Porcupine

Work has been resumed by the Clifton Porcupine Mines, Ltd., of Porcupine, Ont. A favorable feature of this promotion is the assurance that every dollar realized from the sale of stock will be spent on the property. A small mill will soon be built.

Grand Central Requires Large Expenditure

It is estimated that the Chief Consolidated Mining Co., of Eureka, Utah, will have to spend about $200,000 to bring the Grand Central Mining Co., at Mammoth, Utah, control of which it recently acquired, to a point where more economical operation will be possible. Items of this necessary expenditure are given by Cecil Fitch, manager, as follows:

Electrification and additions to hoist $20,000; additional compressor unit and motor, $12,000; general power supply, $5,000; additional tramway equipment, $4,000; additional underground equipment, $11,000; shaft repairs, $13,000; surveying, mapping, geological examination, and similar work, $10,000; total, $83,000. In addition, $100,000 will be required to initiate intensive development and efficient exploration. In the near future when development has reached water level, it is estimated $83,000 will be needed to install complete pumping equipment.

New Guinea Copper Mines Increase Capital

By Cable from Reuters to "Engineering and Mining Journal-Press."

Melbourne, May 25—The annual report of the New Guinea Copper Mines announces an increase in capital to £500,000 sterling. It also recommends the expenditure of £78,000 in development, including the erection of a smelter and converter and a three-mile aërial tramway.

Iron Ore Production in France Two-Thirds Normal

By Reuters Agency

The production of iron ore in France during 1921 amounted to 14,106,368 tons, as compared with 21,918,000 tons in 1913 and 13,871,187 tons in 1920.

Magma Copper Breaks Ground for New Smelter

Work has been started by the Magma Copper Co., Superior, Ariz., on foundations for the new smelter. The site is near the railroad station in lower Superior, about a quarter of a mile down hill from the main shaft. Four grading camps are working on the new broad-gage railroad. W. C. Browning, manager of the Magma, has made inspection of the company's Three R property near Patagonia.

Idaho-Maryland Company May Enlarge Mill

The Idaho-Maryland Mines Co., operating near Grass Valley, Calif., may enlarge its twenty-stamp mill, according to local reports. The company's office is 1213 Hobart Building, San Francisco.

Rhodesia's Gold Output

By Cable from Reuters to "Engineering and Mining Journal-Press."

London, June 2—The production of gold in Rhodesia during April totaled 54,318 ounces.

Magma Chief to Reorganize

A special meeting of the Magma Chief Copper Co. will be held on June 15 at Mesa, Ariz., at which the stockholders will be asked to authorize the sale of the property to a new corporation known as the Magma Chief Consolidated Copper Co. The consideration will be $52,529.61 or 875,494 shares of the new company. Stockholders of the Magma Chief may either take their proportionate share of the money purchase price, or 3 cents per share, or else receive one share of stock in the new company for two shares of Magma Chief stock, subject to an assessment of 3 cents per share.

Magma Chief owes between $15,000 and $20,000. In addition to this, the company's Sombrero Butte property was sold last October on judgments amounting to $8,000. It has been acquired by the new company.

News from Washington

By PAUL WOOTON
Special Correspondent

60 Per Cent of Bureau's Funds for Work on Coal

Balance for Metals and Non-metallics —Mine Economist To Be Added to Staff

Of the $1,580,900 carried in the Interior Department appropriation act for the work of the Bureau of Mines about 60 per cent will be spent for work in behalf of the coal-mining industry. The remainder will be devoted to metal mining matters and work on other minerals. Particular attention is to be given mining problems in Montana during the fiscal year which begins July 1. The matter of ventilation in metal mines is to be accorded special consideration. Two metal-mining engineers are being transferred to Butte. Billings is to be made the headquarters of a deputy mineral supervisor. Increased attention will be given oil in that state.

The report that the Bureau's work in Utah will be curtailed during the next fiscal year is without foundation. There will be no reduction whatever in the amount expended by the Bureau in that state. The impression that there would be a reduction doubtless had its origin in the announcement that some of the ore-dressing work being done in co-operation with the University of Utah is to be discontinued. The intention, however, is simply to transfer that work for a year from the laboratory to the plants at several Utah mines.

A well-qualified research man is to be assigned to work on explosives exclusively. The demands for routine testing have been so great recently that comparatively little work could be done on explosive research, but an allotment of the appropriation for the next fiscal year will be made so as to allow the employment of a comparatively high-salaried man to devote all of his time to that work.

Though the Bureau is receiving a much larger appropriation for its supervisory work in connection with the mineral leasing act, this simply means the enlargement of the present force.

An allotment is being made that will permit the completion of the electrification of the Bureau's experimental mine at Pittsburgh.

A new policy with regard to the Bureau's surgeons is to be put into effect July 1. Under the existing policy the surgeons have been stationed on the mine rescue cars. In the future they will have headquarters at central points where they will be available, when not on duty at mines, for investigation work.

It has become increasingly apparent that the work on certain of the basic problems connected with the mining industry will have to be done at the well-equipped Pittsburgh station, regardless of the section of the country in which the problem arises. For that reason there will be some increase next year in the amount of money allotted to the Pittsburgh station.

A mine economist will be added to the Bureau's staff on July 1. Industries and other departments of the Government are calling more and more on the Bureau of Mines for economic deductions and forecasts in the field of minerals. For that reason arrangements are being made to handle such matters in a more uniform manner than heretofore.

Arrangements have been made for active co-operation with the Joseph A. Holmes Safety Association, the National Safety Council and other safety organizations. At least $6,000 will be made available for that purpose.

Since Congress declined to continue the appropriation for the non-metal work which the Bureau has been doing, it will be necessary to draw on the general appropriation for the funds necessary to draw up conclusions and make the results of last year's work available to industry.

Congress was sufficiently liberal to make it possible to continue at the present rate the amount of work being done in the cryogenic laboratory.

War Mineral Commissioner Needs Engineer's Advice

After an extended study of the claims which have been reopened, the War Minerals Relief Commissioner has begun the issuance of recommendations in considerable numbers. With the exception of the awards to the Whitmarsh Mining Co. and to George H. Crosby, which totaled over $300,000, it is apparent that Judge Robinson is not handing out largesse with a liberal hand. Those who are following the work of the War Minerals Relief Commissioner, however, see evidences of the lack of wisdom of designating an attorney to pass judgment alone on technical matters. There is a feeling in some quarters that the original plan of a commission with three members would be better in that it would make it possible to have an engineer as one of the members.

Mineral Rights Bill Introduced

A bill adjusting mineral rights on homestead and desert land entries designed to protect the homesteader has been introduced in the House by Representative Taylor, of Colorado. It affects homestead entries where subsequent to entry the mineral deposits are embraced in permits, leases or other mineral disposition. The bill provides that whenever the surface of public lands not classified or known to be valuable for minerals is entered under the homestead or desert land laws, the mineral deposits of the land shall not thereafter be embraced in any permit, lease, or entry unless the applicant for permit complies with certain conditions.

Duty on Manganese Ore Restored by Senate

Finance Committee's Amendment Placing It on Free List Rejected— Claimed Survey's Estimates Are Not Up to Date

Advocates of a duty on manganese ore were victorious in the Senate tariff debate when the Senate on June 5, by a vote of 19 to 35, rejected the Senate Finance Committee's amendment placing the product on the free list, and restoring the House duty of 1c. a pound on manganese ore or concentrates in excess of 30 per cent of metallic manganese. The amendment was offered by Senator Nicholson, of Colorado, who delivered a long speech in behalf of protection to the American manganese industry.

The debate largely revolved around the question as to whether American deposits of manganese were sufficient to meet the requirements of the steel industry. Reports of the Geological Survey to the effect that they were not sufficient were relied on by members of the Finance Committee in defence of placing the product on the free list. Advocates of the duty, including Senators Nicholson, of Colorado; Oddie, of Nevada; Bursum, of New Mexico; and Walsh, of Montana, contended that American reserves could supply all needs, and insisted that if the steel industry was protected on articles it produced it should bear a duty on the articles which it purchased, including manganese.

Though not criticizing the Geological Survey, advocates of the duty said that the Survey's reports as to manganese reserves were not up to date, owing to lack of funds. Senator Willis, of Ohio, who opposed the manganese duty, promised to aid in securing more funds.

Senator Willis said that though he did not object to a reasonable duty on manganese, he thought the proposed duty was prohibitive. Senator McCumber said that no other duty could be considered, as less than 1c. a pound was not sufficient, and he left it to the Senate to determine whether the duty should be imposed or not.

An amendment by Senator Poindexter, of Washington, increasing the duty on crude magnesite from ⅜c. per lb. to ½c. per lb. was adopted by a vote of 29 to 22. He explained this would increase the duty from $6.25 to $10 a ton, which, he said, was necessary to protect American producers.

An amendment by the Washington Senator increasing the duty on dead-burned and grain magnesite from ⅜c. to ½c. per lb. was also adopted and likewise an amendment increasing the rate on caustic calcined magnesite from ½c. to ¾c. per lb. An amendment increasing the duty on magnesite brick from ⅜c. to ½c. per lb. was passed over until the brick duties in other schedules were passed on.

News by Mining Districts

London Letter

Geduld Proprietary to Enlarge Mill—Disposal of Ex-enemy Shares in South Africa.

BY W. A. DOMAN

London, May 26—Last week I mentioned that the Geduld Proprietary Mines had decided to increase the capacity of its mill from 40,000 to 65,000 tons' monthly. The consulting engineer gives three reasons for recommending the enlargement: (1) Strong ore reserves position; (2) high-grade ore developed has for some years been equal to the requirements of the enlarged plant; and (3) the accumulation of two and a half million tons of low-grade ore, which it is estimated will yield a profit of 10s. per ton, as all charges in connection with its development have been met. The ratio of high-grade ore to low-grade for many years seems to have been 7.5 to 2.5. Apparently, the management intends to send ore to the enlarged mill in these proportions, the average value then being 7.2 dwt. Working costs are now 20s. 8d. per ton, and it is hoped, in view of the improved industrial position, to get them down to 18s. per ton. At an average milling of 850,000 tons per annum—the actual capacity of the mill is about 12½ per cent in excess of the nominal—the reserves with devolopment rock would supply requirements for about eight years.

According to a cable dispatch received earlier in the week, a discovery of auriferous ore has been made at a place called Muriel Tank, about 300 miles northwest of Sydney, New South Wales. As usual in most gold finds, high assays are reported—up to 50 oz. to the ton, in fact. At present the news is received here with a good deal of skepticism, in view of the manner in which such finds have a habit of pinching out.

Nigerian tin-mining companies are anxiously looking forward to the time when the price of the metal will improve, for according to engineers' reports, some of the deposits are unusually rich. The Bisichi company's ground is said to contain an average of 3 lb., with an average depth of 21 ft. The Keffi company reports that it has proved an average of 3.1 lb. over an average depth of 37 ft. So far, 1,355 tons of tin has been proved by the Keffi company and values are extending both up and down the stream.

Apparently, the Custodian of Enemy Property in the Union of South Africa, in conjunction with the Public Trustee on this side, is about finishing his labors, so far as the disposal of ex-enemy shares in mining companies is concerned. The Consolidated Investment Co., otherwise Barnato's, have acquired from these officials the shares in their group of companies; the Union Corporation has acquired the shares of its group; the Central Mining and Rand Mines have acquired the respective shares in their group, and now it is announced that the Consolidated Mines Selection, together with the Anglo-American Corporation of South Africa, have acquired the shares of the companies which they control. The numbers are not exactly known, but there are approximately 80,000 Brakpans, and 70,000 Springs Mines in question.

I gather from a conversation I have had with a technical man just arrived from Perth, that the outlook for the Hampton field is not particularly bright. He tells me that it is just "touch and go" as to whether the lode in the Celebration mine will continue in depth, but according to him it would have to persist a considerable distance before shareholders could expect to receive any return on their money.

The Golden Horseshoe Estates worked under abnormal conditions last year, only a minimum amount of development work being done, which necessitated drawing a large proportion of the ore mined from the higher grade stopes, and, naturally, this reduced the tonnage and value of the ore reserves. The mill ran to only about 60 per cent of its capacity. If one takes the cost of mining, excluding development on tonnage milled last year, there is a substantial rise of 6s. 2d. per ton, but if the costs are worked out at per oz. of fine gold, it is seen that the expense last year was £4 per oz., in comparison with £4 3s. per oz. in 1920. The per ton use is due, of course, to the milling of a smaller tonnage—104,226 tons, against 125,340 tons. Last year the ore sent to the mill was the lowest quantity since 1901.

SPAIN

Bilbao Iron Ore Consignments Show Increase

Madrid, May 20—During the first three months of 1922 the port of Bilbao consigned 392,363 tons of iron ore, against 262,721 tons in 1921.

Rand Gold Industry Normal by Fall, Smuts Says

By Reuters Agency

Capetown, May 22—In outlining the Government's industrial policy in the Union House of Assembly, General Smuts foreshadowed a new lease of life for the gold mining industry and pointed out that efforts were being made to secure an outlet for South African coal on the Indian Ocean. The gold industry, the Premier said, should be working normally by September, thus absorbing most of the unemployed, but provision must still be made for the semi-skilled and unskilled workers. The Government hoped by means of railway construction, irrigation and afforestation schemes to absorb all of them and the renewal of these men from the Rand was already proceeding steadily.

Johannesburg Letter

Many Still Unemployed—Operations Hampered by Loss of Natives

BY JOHN WATSON

Johannesburg, May 2—Recent reports from various branches of the South African White Labor Bureau show a serious state of unemployment following the strike. The report of the Johannesburg branch showed close on 1,600 applications for work in March, being an increase of 400 as compared with February. Of these March applicants, work could be found for only 419.

Certain trade unionists complain of victimization as to the gold mines; the opinion is expressed, however, that these same men need to be reminded once more, that the strike which their leaders (or misleaders) precipitated, had the effect of causing an exodus of nearly 50,000 native mine-workers from the Rand to their homes. It will take several months of recruiting to restore that number; also certain low-grade mines suffered severe losses owing to the stoppage and dislocation. Recent figures show that about 5,000 white men are now employed underground by the gold mines as compared with 9,000 before the strike (excluding officials in each case). If surface workers and officials are included the total number of Europeans now employed is approximately 14,000.

The annual general meeting of the Witwatersand Native Labor Association, Ltd., was held on April 24, H. O. Buckle presiding. He referred to the serious loss of 56,000 natives from the mines caused by the recent strike. Such a loss would require considerable time and recruiting to make up. Roughly speaking, one European is employed on the mines for every ten natives. Mr. Buckle also referred to the ban on the employment of natives from north of latitude 22 degrees south of the equator, which still operates. Several commissions have recommended the removal of this ban, but, so far, our Government has not removed it.

In the report from Bloemfontein, a slight boom is indicated in alluvial diamond digging at Parys, on the Vaal River. It is, however, uncertain at present to what extent this proposition will be payable.

A promising discovery of gold has been made in the Gwanda district on the Insindi ranch, a mile north of the Insindi kopjes. The Abercoon Gold Mining Co. has secured an option. Several small workers in various parts of Southern Rhodesia are said to be making good monthly profits.

It recently transpired that a certain debris washer treating tailings heaps at Kimberley has recovered diamonds worth over £36,000 during the past 5¾ years. The city council has now prohibited such washing on heaps under its control.

Melbourne Letter

Construction Work at Hampton Plains —New Mill at Muir's Gold Reef Started—Planning Smelter in Papua

BY PETER G. TAIT

Melbourne, May 8—Matters are moving slowly in the Hampton Plains field, West Australia. The Celebration treatment plant is at work, but only fifty tons daily is being crushed. The White Hope is engaged on the erection of a small treatment plant. Hampton Properties is sinking a main shaft on Block 45 to prove the extent of the orebody developed by prospecting shafts. The erection of a power and treatment plant on this lease is under consideration. The Golden Hope is being developed north and south of the 100 level; the average value of the last 244 ft. is given as 44s. per ton.

The Western Australian government has appointed Captain William Jones as leader of a properly equipped prospecting party which is to be sent out under the scheme devised by the prospecting board. The scene of operations has not yet been announced but it will probably be in the Yilgram field beyond Hampton Plains and the back districts of Kalgoorlie.

The battery at Muir's Gold Reef's Mines, nine miles from Te Puke, New Zealand, was officially opened by the Prime Minister recently. Twenty head of stamps are operated, together with four tube mills. It has a capacity of 125 tons per day. J. R. Noble, the manager, reports that there is in sight sufficient high-grade ore, averaging 71s. per ton, to run for two years or more.

The New Guinea Copper Mines, Ltd., which is operating the Dubuna and Laloki mines, in Papua, is negotiating with the commonwealth government, which controls the territory, to take over the company's jetty and railway line (the only railway in Papua) for £45,000. If the negotiations are completed, it is understood, the company will raise additional capital to develop the mines and proceed with the erection of a smelter at Bootless Inlet. As the ore is a valuable flux for mixing with siliceous ores, it is anticipated that when the Australian copper mines are in a position to resume there will be an outlet for about 3,000 tons per month.

BURMA

Burma Corporation Reports Assays of High-Grade Ore

Bawdwin—The Burma Corporation reports assays of samples taken in its seventh level crosscut, in which high-grade ore was recently cut, as follows:

	Silver, Oz.	Lead, Per Cent	Zinc, Per Cent
4— 35 ft.	5	7	11
35— 50 ft.	10	14	6
50— 95 ft.	4	5	6
95—120 ft.	8	15	10
120—135 ft.	7	9	5
135—145 ft.	48	47	22
145—149 ft.	12	19	7

A deflected crosscut has been started so as to get the full section of the orebody.

CANADA

British Columbia

Twelve Dominion Geological Survey Parties to Work in Province

Victoria—Government mining engineers in British Columbia have addressed between three and four thousand prospectors or potential prospectors in lectures delivered during the past winter. In one district the engineer was called upon to speak to the children attending public schools. It is generally agreed that no more effective method could be found for stimulating interest in minerals and the mining industry.

The first of the vessels leaving British Columbia and Washington ports for Nome, Alaska, is on her way north. The season has opened, and mining operations there soon will be in full blast.

The extension of the Premier mine road, the construction of a trail into the Unuk country, the building of a over the Bear River, and the rebuilding of that over the Marmot, as well as considerable maintenance work, are some of the probable activities of the provincial government in the northwestern section of British Columbia this year. It is also suggested that a road should be built further up the Kitsault Valley than is reached by the Dolly Varden railroad, and that there should be a trail from Alice Arm to Stewart. The latter is rather an ambitious project, but the route will be surveyed this year.

There will be twelve parties of the Geological Survey of Canada working in British Columbia this summer. Nine of these will be on geological investigation and three on topographical surveys. Those who have been assigned to field work are: J. D. MacKenzie, head of the British Columbia office of the Geological Survey; George Hanson; M. F. Bancroft; W. L. Uglow; S. J. Schofield; Victor Dolmage; G. A. Young; W. A. Johnston; C. A. Cairnes; W. A. Cockfield; C. T. Shepherd, R. G. Bartlett and D. A. Nicholls.

If the Dolly Varden property passes into the hands of George Wingfield, of the Goldfield Consolidated, and associates, it is suggested that a new company will be formed for the further development of the mine and adjacent claims. The plan now proposed is the formation of a company in which will be represented other creditors of the Taylor company, shares being allotted them in proportion to their claims.

Ontario

Peterson Lake to Reopen Mill—Porcupine Crown Finds New Vein

Cobalt—No ore was shipped from Cobalt over the T. &. N. O. Ry. during the week ended May 26.

At the annual meeting of the Peterson Lake it was announced that the company's mill would be reopened. About 10,000 tons of 9-oz. ore is now on the dumps. Treatment of old tailings has been started by the Dominion Reduction.

La Rose is pumping out its La Rose Extension workings, which have been flooded for ten years. Considerable development work will be undertaken from the 350 level.

Engineers for the New York syndicate which recently took over the Colonial are on the ground preparing to start work.

Kirkland—Negotiations for the proposed merger of the Teck Hughes and the Orr are still pending, but nothing definite has been done. Negotiations for the purchase of Teck Hughes by English interests are also reported.

The Post and Wright claims, one of which adjoins the Tough Oakes, have been taken under option by New York people.

The Patricia property at Boston Creek is to be reopened. There is a small high-grade vein, partly developed.

Tough Oakes interests have taken an option on Kirkland, west of the Kirkland Gold, and will diamond drill it.

An examination is being made of the Boston Creek and R. A. P. properties in Boston Creek.

Arrangements have been made for the development of the Chaput Hughes from the workings of the Kirkland Gold.

During April the Lake Shore treated 2,320 tons of ore and recovered $47,112, an average of $20.30 a ton.

The new vein of the Wright Hargreaves recently found in the main shaft below the fifth level has shown 6 to 8 ft. of $13 ore.

The main shaft of the Sylvanite has reached 500 ft., and lateral work has been started.

The report of the Argonaut for the year ended Jan. 31, 1922, states that the new mill should be in operation by next September. Developments to date on the 200 level indicate ore of $15 grade, and on the 350 level, ore of $20 grade. Current assets over liabilities are placed at $24,529.

The Highland Kirkland has completed is first 1,000-ft. diamond-drill hole, and has started another.

Porcupine—A new vein has been found on the 500 level of the Porcupine Crown near the Hollinger boundary. The new plant on the company's Larder property has been completed, and underground work has been resumed.

It is stated that to finance the Vipond properly about $200,000 additional cash will be needed, and this will probably necessitate a reorganization. Cash on hand will not carry operations beyond next fall.

The Canadian Pacific Ry. will build a short spur line from a point near Glendower station to the feldspar mines situated near Thirteen Island Lake, the construction of which is expected to increase the production of feldspar, which has hitherto been limited owing to transportation difficulties.

MEXICO

Mining Industry Depressed, with Exceptions—Awaits Clearer Defining of Political Future

Mexico City—Almost at the close of the fiscal year, the mining industry throughout Mexico finds itself, with notable exceptions, in the doldrums. Because of geographical conditions there is naturally more activity along the northern frontier and the west coast where transportation is not so much effected by prices or distances. Metal prices have been more favorable recently but increased railway rates, and bolshevik tendencies in state legislation, combined with a general tendency to hold all important enterprises until the future of political conditions (including recognition by the United States) has been more clearly defined.

The same conditions hold good with oil development. While new leases are being made and exploring parties are covering the country, actual production may be looked to decrease rather than increase, until the legal status of the oil investments is made more clear and more certain. So many obstacles are placed by local officials in the way of getting drilling permits, that no new wells are planned except in cases where the leases oblige. With recognition, and some sort of a mutual agreement between the two governments, the obscure clauses in the oil legislation would be cleared up, and great activity might be expected. Recent decisions of the Supreme Court have been favorable to contentions of foreign oil companies, and are excellent, so far as they go, but they fail to cover many mooted points, and investors feel they are still lacking in essential guarantees for large further outlays.

ARIZONA

United Verde to Start Second Reverberatory

Jerome—A reverberatory and a blast furnace are working at the Clarkdale smelter of the United Verde Copper Co. and a second reverberatory is to be started. The plant resumed work with an initial consumption of 700 tons of ore a day and with 300 employees. The first unit of the Cottrell smoke-treatment plant and a water-softening system are to be operating this month. Concrete is being poured on the foundations of the crushing plant.

Oatman—E. L. Ransome, of the U. S. Geological Survey, is working on a report on the Oatman district of Mohave County, Arizona. A brief digest will be issued soon, it is told, but the main report is likely to be delayed for a year or more. Mr. Ransome, who has done much similar work in other camps of the Southwest, is said to disagree with other geologists in his theory concerning the deposition of gold at Oatman.

Drilling is being done by fifteen Oatman mining companies, with as many more sinking their shafts to greater depths.

CALIFORNIA

'49 Celebration at Sacramento Cuts Kennedy's Working Force

San Francisco Correspondence.

San Francisco—A rich gold strike has been made by James Walsh in an abandoned mine at Donnelly Gulch near Lewiston, Trinity County. At French Gulch, Shasta County, a satisfactory clean-up was made at the Washington. The Brunswick, the Sybil, the Gladstone, and the Milkmaid mines are operating their mills.

The New York and Arcadia mines near Greenville, Plumas County, are being reopened by W. Parsons. The Surcease mine, at Las Plumas, is being equipped with a mill and a mine plant. Preliminary work has resulted in a sufficient tonnage of ore to warrant further operations. The property is operated by the Gruss Mining Co.

At Grass Valley, the Idaho-Maryland is drifting from the bottom levels of the old shaft, with satisfactory results. Local reports state that the company will start its main shaft in the summer and that it will probably enlarge its mill. The Golden Center Mining Co., which formerly operated in the Grass Valley district, has developed a number of oreshoots in its Blue Mountain property, thirty miles from Porterville. Arrangements are being made to operate a five-stamp mill and secure electrical power for the mine plant. The driving of the tunnel at the Bullion mine, in Secret Canyon, near Downieville, has been resumed. Gold nuggets are being found in the Placer Gold Lead mine, at North Bloomfield, and expectations of cutting the pay channel are high. Gravel from the Malikoff strike has been washed with satisfactory results.

The Vandalia mine, near Shingle Springs, El Dorado County, has been leased, and operations are to be started. Equipment is being installed at the Rich Flat mine near Ringold.

Work has been started at the Shotgun mine, near San Andreas. G. F. Snyder, of the Moore mine, at Jackson, is president of the company.

At Jackson, the Kennedy Mining & Milling Co. operated as many as eighty stamps recently but is now down to twenty stamps. The '49 celebration at Sacramento is responsible for the curtailment. When the miners return, it is expected that eighty stamps will be kept in operation.

The April output of the California Rand is stated to have approximated $175,000. Dividends for the first four months of 1922 aggregated $640,000. The boom in the Randsburgh district continues.

Russian Council To Lease Mines in Urals

By Telegraph to "Engineering and Mining Journal-Press"

Moscow, May 24—The Supreme Economic Council has decided to lease for a period of ten years the gold and platinum mines in the Urals.

NEVADA

Town of Manhattan Suffers Loss by Fire—Spanish Belt Mine to Resume

From Our Special Correspondent.

Virginia City—The Con. Virginia has decided to abandon all levels below the Sutro tunnel or 1,750 level. The pumping stations on the 2,050 and 2,250 stations are being dismantled.

The east crosscut from the north drift, started at 888 ft. from the Hale and Norcross tunnel, in Savage ground, is reported to have cut milling ore at 100 ft.

Battle Mountain—Construction material and machinery for the Betty O'Neal mill is beginning to arrive and grading for the mill will be started at once. The main drainage tunnel is in 1,740 ft,, with 210 ft. to go to connect with the vertical shaft. Progress is being made at the rate of 8 ft. per day. A new raise from the 150 level has passed through 15 ft. of vein matter, all of which is said to contain commercial values.

Tonopah—The Spanish Belt mine, 50 miles north of Tonopah, which has been closed during the winter on account of deep snow, is preparing to resume operations.

Manhattan—The mining town of Manhattan suffered a severe fire loss the night of May 26. The major portion of the business section was wiped out, with a loss estimated at $75,000.

Goldfield—To date twenty carloads of ore have been shipped from the Silver Pick lease in Red Top ground, and the extent of the orebody is still unknown. The length of the oreshoot, so far as developed and stoped, is about 85 ft. Recent shipments average $40 per ton. Three ore shipments have been made by Simpson and Porter from their lease on the Combination mine. The first two shipments ran $320 and $350 per ton, but the last is expected to run about $150 per ton.

IDAHO

Bonner County Mining Association Reorganized

Hailey—Development has been resumed on the War Dance mine, on Deer Creek, a property credited with a large output in the early days.

Sandpoint—The Bonner County Mining Association has been reorganized, and will be henceforth affiliated with the Sandpoint Chamber of Commerce. It will be known as "Bonner County Mining Bureau of the Sandpoint Chamber of Commerce." Officers elected under this arrangement are: M. B. Dunkle, president; W. F. Shutz, vice-president; J. C. Cranston, treasurer; H. L. Thomason and W. C. Ames, committeemen, F. O. Hagie, secretary.

Talache—The Talache mine now has a payroll of 150 men, 110 of whom are employed underground. Mill feed averages 110 tons per day, with a 95 per cent extraction. By the end of May the fifteenth car of high-grade concentrates was shipped.

UTAH

New Owners of Grand Central Plan Extensive Development

From Our Special Correspondent.

Salt Lake City—The 10 per cent reduction in interstate freight rates ordered to take place July 1, as reflected in lowered prices for mining supplies, is expected to relieve Utah mines of some of the burden of costs, which are still much higher than in the pre-war period. The smelters deduct from ore settlements shipment charges paid on bullion from smelter to refinery, so these are borne by the shipper. When the freight rate reduction was made last fall, the reduction was transmitted by the smelters to the shippers.

In regard to intrastate rates on ores and on coal, these have been proportionally high, and for this reason were not increased when the flat rate increase of 25 per cent above the McAdoo rates of June, 1918, was ordered on Aug. 25, 1920. If the theory is followed that intrastate rates should be on a substantial parity with interstate rates, and the 10 per cent reduction can be gained on freight rates on ores within the state, it will be possible for Utah mines to ship lower grade ores to the smelters and so increase their output.

Eureka—Mines of the Tintic district shipped 209 cars during the week ended May 27, the largest output for one week in two years. Shippers were: Chief Consolidated, 61 cars; Tintic Standard, 54; Iron Blossom, 22; Colorado, 15; Victoria, 13; Grand Central, 12; Eagle & Blue Bell, 9; Gemini, 5; Mammoth, 3; Dragon, 4; Sunbeam, 3; Swansea, 2; Sioux Consolidated, 1; Centennial-Eureka, 1.

A report by the new interests in control of the Grand Central outlines an extensive plan of development. Minority stockholders in the Grand Central have been offered 60c. a share for their stock, the price paid the majority stockholders, when control was acquired by the Chief Consolidated Mining Co. or the privilege of exchanging their Grand Central stock for stock in the Chief Consolidated on a basis of ten shares of Grand Central stock for one share of Chief Consolidated stock. This is done in view of the fact that Grand Central stock is non-assessable, and to obviate difficulties in the way of financing operations. Up to April 30, since the acquiring of control by the Chief interests, $53,000 had been advanced to the Grand Central by the Chief, and notes taken. To bring the property to the desired point of economical and safe management, it is estimated that an expenditure of $200,000 may be needed.

The superintendent's report shows that 3,682 tons of ore was shipped from the time the mine was leased up to the end of the first quarter. This ore yielded, after payment of smelting, sampling, and transportation charges, $84,874. Net operating loss, after payment of all charges was $3,575. This did not include charges for equipment and for miscellaneous expense, which amounted to $40,206 involving an indebtedness to the Chief Consolidated for that amount, which, since the close of the quarter by additional expenditures has been raised to $53,411.

Park City — Shipments for the week ended May 27 amounted to 3,437 tons, compared with 2,410 tons the week before, and is the highest for any week in the last two years. The Ontario is adding to the output of the camp by shipments from its tailings dump to one of the valley smelters. Shippers were: Ontario, 1,214; Silver King Coalition, 808; Park-Utah, 707; Judge, Daly West, Daly, 707. In regard to the new find in the Ontario on the 1300 level east of the Ontario fault, the management states that the ore is of excellent grade but that not enough work has yet been done to determine its extent. Energetic development of the oreshoot is being done and the outlook is said to be most encouraging.

OREGON

Efforts Made to Finance Rebuilding of Sumpter Smelter

Baker—The mining future of Baker County depends to some extent upon the success met in financing plans for the rehabilitation of the smelter at Sumpter, a 300-ton capacity plant, which was built many years ago. Its operations were limited, owing to poor management and financial difficulties. The plant is in good condition, considering the long idleness and it is estimated that the expenditure of $30,000, chiefly for electrical equipment, will put it in running order. The promoters of the enterprise are hopeful of making financial arrangement so that operations will be resumed this summer.

The town of Sumpter, partly destroyed by fire four years ago, and near which the smelter is situated, is the center of an area credited with the production of considerable gold and silver. The lode gold was largely derived from free-milling ores, which, however, became sulphides at depth. The region is served, in a general way, by the Sumpter Valley Ry., a narrow-gage line, extending from Baker to the John Day country.

Bourne — Preparations are being made for resumption of mining and milling at the E. & E. mine.

Cornucopia District—The connecting raise between the long Last Chance tunnel and the upper workings of Baker Mines Co. is making rapid progress, having reached a point which is over 600 ft. above the Last Chance tunnel level.

Susanville—Work throughout this section has been hampered this season by the large amount of snow in the hills, which has exceeded all known records for this time of the year.

Homestead—After a short shutdown, due to necessity of raising money with which to put in pumping machinery, the Copper Syndicate, adjoining the Iron Dyke property, has resumed work with a small crew.

MICHIGAN

The Copper Country

Arcadian's New Baltic Opening Still in High-Grade—C. & H. to Run Ten Stamps at Calumet

BY M. W. YOUNGS

Houghton—Copper is going out of the Lake district by rail as well as by water and final reports of May shipments should show an encouraging total. The outlook for June is equally as good, and if the present demand continues the local docks will soon be clear of surplus metal.

The rich streak in the south drift at the 1,100 level of Arcadian Consolidated's New Baltic shaft continues. It has now been cut for a distance of 75 ft. and the high values persist. The vein rock is charged with heavy copper and it is uniform throughout the breast. Good values also continue in the north drift at the same level. For the present all efforts will be centered on pushing the drifts in the 1,100 and 942 levels, but eventually the shaft will be sunk to much greater depth to test out the values in the lode.

Calumet & Hecla is preparing to resume work soon in the haulage level in its conglomerate department. At the same time, work will be resumed in the raise at No. 12 shaft, the southern terminal of the tunnel and the main supply, power and pump shaft. One thousand more feet of drifting will bring the tunnel to its termination. At the north end, the Red Jacket shaft will be used for hoisting. Eventually, all other conglomerate shafts will be abandoned and all mining of the conglomerate lode at depth will be from the haulage level.

With the resumption early in June of mining operations on a larger scale in Nos. 9 and 10 shafts, South Hecla, of Calumet & Hecla, more stamps will be needed in the Calumet mill. Eight now are in operation but two more are being overhauled preparatory for use.

Though work is proceeding satisfactorily on the construction of the new power plant at No. 2 Gratiot shaft, Seneca, there is no immediate necessity for the completion of the task, as the present hoist will be ample for some time. The shaft is bottomed at 1,500 ft, and the hoist has a capacity considerably greater than that. The improvement of the shaft has reached the thirteenth level, and repairs will proceed to the fifteenth before sinking is resumed.

Gogebic Range

Oliver Company Shipping Ore Hoisted from Eleven Shafts

Ironwood—The Oliver Iron Mining Co. started shipping the ore hoisted at its ten shafts in the Ironwood district and one in the Bessemer district on June 2. The shafts of the Tilden mine are served by the St. Paul railroad, and the company has not yet started shipping over that road. No announcement has been made as to

when the steam shovels will be started loading stockpiles.

The Eureka was the first mine of the Oglebay, Norton Co. to receive orders to start shipping, its ore hoisted May 27 being shipped to the docks. Shipping from stockpiles started a few days later.

The coal strike has not directly affected the operations of the mines in the Lake Superior district. There is an abundance of coal on the docks at the head of the Lakes, and several cargoes have even been shipped back down the Lakes. In addition many operators have considerable coal at their mines remaining from last year. The effect on the steel business has, however, been reflected in some measure by the delay in shipping ore from the mines. This delay has been more largely due to the uncertainty of rail and lake freight rates.

MINNESOTA

Minnesota Steel Co. to Start Plant at Capacity

Duluth—The Minnesota Steel Co., a subsidiary of the U. S. Steel Corporation, has received orders to start its plant at capacity at the earliest possible moment. One furnace has been running at half capacity for several weeks making pig iron. Besides the two furnaces, five open hearths, the epen pit, rail mill, merchant mill and the nail and wire mill will be put in operation. The plant when running at full capacity will turn out 40,000 tons of steel per month.

Mesabi Range

Biwabik—The Pickands Mather & Co. has started ore shipments from stockpile at its Belgrade mine. At the Biwabik mine, operated by the Biwabik Mining Co., it is anticipated that ore will be shipped soon.

Chisholm—Shipments from the stockpile of the Alexandria mine, operated by the Hanna Ore Co. are being forwarded daily to the G. N. docks at Allouez.

Nashwauk—Ore operations at the Harrison and Patrick open pits has been started by Butler Brothers and are being worked to capacity. The concentrating plants have also been placed in operation.

Vermilion Range

Ely—All shaft ore from the Pioneer, Sibley and Soudan mines, properties of the Oliver Iron Mining Co., is now being sent directly to the dock.

Cuyuna Range

Work To Be Started at Pennington Pit—Nine Mines Operating Full Time

Ironton—Work is to be started at once at the Pennington open pit. The pit is being unwatered, and will soon be in the shipping class again. It has been idle since November, 1920. Plans anticipate the production of 150,000 tons this season, a portion of which will come from the Inland Steel Co.'s Armour No. 1 mine, which is operated through the Pennington pit by the Todd-Stambaugh interests. It is estimated that ore available to steam shovel in these two properties will be exhausted in another year's operation, at which time underground methods will be adopted.

The opening of the Pennington brings the total number of mines operating full time on the Range to nine, out of a total of sixteen iron-ore properties.

Joplin-Miami District

Tulsa-Quapaw Company Buys Niangua Property—Over 100 Mines in Operation

By P. R. Coldren

Joplin—The Tulsa-Quapaw Mining & Investment Co., has purchased the concentrator and two mines of the Niangua Lead & Zinc Co., at Picher, Okla., for a cash consideration of about $50,000. The Niangua company developed the two properties in 1918. It first bought and developed the east twenty acres of the forty-acre tract, and erected a mill. Then it bought the Hare mill and mine on the West 20, and called it the Niangua No. 2. Some months afterward, the No. 1 mill burned, and mining afterward was carried on at the No. 2 concentrator, and the two mines were cut together underground, though unsatisfactorily.

The new owners say they will build a surface railroad connecting the mines and mill the dirt taken from the two properties, and also from a third property on a twenty-seven-acre tract adjoining on the east, at the No. 2 Niangua mill. It is understood the Niangua people paid $150,000 for the Hare property alone, and that they at one time were offered $300,000 for the forty-acre tract with the mills. Some months ago the company went into bankruptcy, and the mill has been idle for some time.

The Tulsa-Quapaw company is made up mostly of capitalists, including J. R. and C. C. Cole, who already are interested in several Picher mines, notable among them being the Dorothy Bill. The sale was made through George Moore, of Joplin, who retains an interest in the property.

No definite results have been announced from the recent hearing before the special Indian commission at Miami, respecting the estimation of values of mining lands on the Mary and Eudora Whitebird, Harry Crayfish, Slim Jim, and Sin-tah-hah-hah allotments. An erroneous report was made to the effect that the commissioners would demand a bonus from the operators, but it is officially stated that no such decision has been reached. As a matter of fact, the decision of the local commission must be sent to Washington and be approved by Indian Commissioner Burke and issued by him before it will become official. It is expected a report will be made within the next fortnight.

The New York mine, in the Picher camp, is just being opened up by Jefferson City, Mo., capitalists who also own the Cortez and King Brand mines in this field, and is proving a promising property. Operations are being carried on at a depth of 235 ft. and ore giving a 25 per cent recovery (locally speaking) is being taken out. There is little lead.

The United Zinc Corporation, the Charles M. Schwab interest in this field, is preparing to reopen its Royal mine, in the Picher camp. The Manhattan mine, which is another of this company's properties, is in operation and giving a good account of itself.

Although few mine sales are being reported, there is more activity in the Tri-State section than for many months. More than 100 mines are in operation, and there is a considerable shortage of shovelers at the mines.

ALABAMA

Conditions in the Birmingham District Improving Steadily

By George Huntington Clark

Birmingham—Optimistic predictions as to iron and steel production in Alabama for May have been more than realized. Steel production is steadily increasing, the Gulf States Steel Co. now having three of its six open-hearth furnaces going, and the finishing mills in part on double time. The Tennessee Coal, Iron & R.R. Co. is closely approximating normal steel output, if that figure has not been already reached.

The determining index of Southern merchant iron production, is the output of the Sloss Sheffield Steel & Iron Co., the largest producers of this class of iron in the South, now operating five of its six stacks, which is above normal.

There are now twenty or twenty-one furnaces active in Alabama, as compared with six on Jan. 1, and five on July 1, 1921. The increase, during 1922 has been steady during each succeeding month.

It is now estimated that the production for June should approximate, if not exceed, maximum production realized during any one month for the last eighteen months.

Iron mining in Alabama as usual is largely confined to the operations of the iron-making corporations, there being few, if any, independent mines putting out any class of iron ore for open market sale.

Reserve ore stocks have been drawn upon rather heavily so far during the year, and the scale of mining must soon increase, running approximately to an output of about 325,000 tons per month, or approximately 72 per cent of normal.

The opinion of the Tennessee Coal, Iron & R.R. Co. as to the stability of the iron and steel trade seems indicated by wage increases of 15 per cent to ore, and approximately 10 per cent to coal miners, effective on May 15.

The present percentage of unemployment in the district, in so far as iron and steel making is concerned, seems negligible and is steadily decreasing.

The Present Situation at the Mines

Few Copper Companies Remain Shut Down—Freight Rate Cut Expected to Stimulate Production—Coal Stocks Ample—Further Improvement in Lake Superior Iron Country—Lead-Zinc Activities Increasing

By A. H. Hubbell
News Editor, *Engineering and Mining Journal-Press*

ANNOUNCEMENT of the reduction in freight rates has caused little or no visible change as yet in operations in the metal-mining districts of the country. Undoubtedly it will stimulate production. It does not apply, however, to iron ore moving from the Northern ranges to the Lake Superior docks, this commodity being subject to a separate ruling not yet handed down, as a result of which iron-ore prices have not been quoted so far for 1922.

Coal stocks appear to be ample for the present, and no inconvenience is reported resulting from the strike. Skilled labor is becoming scarce in many districts, and in the Joplin zinc-lead district a shortage of shovelers has suddenly developed. Wages are at the low point, the general situation hardly permitting further cuts. In some districts they have already made some advance, particularly in the iron country and in the Birmingham district of Alabama. The average cost of supplies is rising slowly, Dun's index for June 1 being $169.977 compared with $164.444 on Jan. 1 and $159.833 on July 1 last.

In less than six months the copper-mining industry has passed from a position of widespread stagnation to one where almost all of the important operators of the country are producing. This transition, which began with Anaconda's resumption on a limited scale last January, was completed recently when North Butte and Davis Daly, in Montana, and the United Verde, in Arizona, started work. The Phelps Dodge branches at Tyrone, N. M., and at Clifton-Morenci remain shut down; likewise some of the smaller properties in northern Michigan. Stagnancy still prevails in the Shasta copper belt in California. Elsewhere in the United States important plants are running.

At Butte, about 10,500 men are employed. Anaconda is working thirteen mines and has both smelters at half capacity and its zinc plant at full capacity. East Butte has increased its force to handle Davis-Daly ore. At East Helena, the A. S. & R. Co. has several hundred men engaged.

Of the porphyries, Utah and Nevada Consolidated have reached their temporary objective of half capacity, with Ray and Chino lagging. In Arizona, the Copper Queen has increased its output from 6,250,000 to 7,500,000 lb. per month and is taking concentrates from its new Moctezuma mill at Nacozari. Old Dominion continues its monthly rate of 2,000,000 lb. Calumet & Arizona and New Cornelia are running at 60 and 40 per cent capacity, Miami is operating at 80 (as last year), and Inspiration is producing at a rate of not less than 5,500,000 lb. per month.

Elsewhere in the West, Engels, in California, is producing over 1,100,000 lb. per month, and Granby at 75 per cent capacity.

Copper production in northern Michigan is slowly increasing, May's output of refined metal being estimated at 11,550,000 lb. against 9,785,000 in April, or 52 and 44 per cent, respectively, of the district's pre-war normal of 22,000,000 lb. a month. Calumet & Hecla's production is 55 per cent of normal, that of Copper Range 97, Quincy 76, Ahmeek 93, and Isle Royale 45. Mohawk and Wolverine are producing at capacity.

In the Ducktown district of Tennessee both the two producers are running, Tennessee Copper at 70 per cent of capacity and the Ducktown S. C. & I. Co. at capacity.

Though conditions are still unsettled in the Lake Superior iron country, improvement is marked. Iron-ore production in May, though far below normal, was the largest since the 1921 season closed. Delay in quoting iron-ore prices is naturally keeping production down. On the Mesabi and Vermilion ranges it is reported that though active properties are operating on a 65 per cent basis their shipments are but 40 per cent of normal for this time of the year. About 9,000 men are working, compared with 16,000 normally, and on the Cuyuna 900, against 1,600 normally. On the Michigan ranges, about three-quarters of the men usually employed are at work, and production is on a similar basis.

In the Birmingham district in Alabama reserve iron-ore stocks have been drawn upon rather heavily and an increase in output to about 70 per cent of normal is considered imminent. About twenty furnaces are in blast, compared with six on Jan. 1. Production of iron and steel is continuing its steady increase, as it has from the first of the year.

Better prices for lead and zinc, together with the forthcoming reduction in freight rates, have greatly improved the outlook for producers of these metals. The production of zinc ores by Butte & Superior and Anaconda continues large. In the Cœur d'Alenes, in northern Idaho, the Hecla Mining Co. is producing at the increased rate of 4,000 tons per month, against 3,500 a month ago, and the Federal and Bunker Hill companies without change at 5,000 and 6,000 tons, respectively, giving a total for the district of 15,000 tons per month. Bunker Hill's smelter is running two furnaces, handling 500 tons per day. Elsewhere in the Pacific Northwest smaller operators are more active. Trail is handling a normal tonnage. The Northport smelter is shut down. Tacoma is running at reduced capacity.

The number of mines in operation in the Joplin-Miami zinc-lead district has now passed the hundred mark, and others, particularly in the Picher section, are preparing to resume, this compared with seventy-five in operation on Jan. 1. Production is about 10,000 tons a week.

In the Wisconsin zinc-lead district, the production of zinc concentrates has recently increased and stocks on hand decreased. At the present rate, production is about 35 per cent of normal. Labor is plentiful.

Zinc operations in the Mascot district of Tennessee are somewhat less than half of normal.

Activity is slowly increasing in the southeast Missouri lead belt, and present plants are running at capacity. Construction of the 1,000-ton mill of the Annapolis Lead Co. is progressing. St. Joseph Lead has raised wages 10 per cent.

In California, there is considerable activity on the Mother Lode and among the smaller gold-mining operators in the north. The North Star and the Empire Mines, at Grass Valley, are running at capacity. The Randsburg silver camp remains in the limelight. Dredging companies are busy.

Nevada conditions are normal. Tonopah, the principal camp, is producing steadily, and on the whole there is considerable activity in the state.

In Utah, Park City, Bingham and the Tintic district continue busy, operations at Bingham progressing on an increasing scale. The Garfield smelter is handling Utah Copper's concentrates and the other Valley smelters are treating their customary tonnages. The Tooele plant has resumed.

Mining in Colorado at present displays no marked activity, save in a few localities, and these scattered. Strong efforts are being made to improve the situation. Conditions at Cripple Creek are unpromising.

In the Black Hills of South Dakota, the Homestake and Trojan companies are the only gold producers, their output totaling about $750,000 per month.

In Ontario, the gold producers at Porcupine and Kirkland Lake are striving for new records. Production from Cobalt continues normal, with the McKinley Darragh and the Dominion Reduction reopening their properties. International Nickel has reopened its refinery, evidencing better conditions in the industry. Activity in the Sudbury district is confined to the Mond company's limited operation.

THE MARKET REPORT

Daily Prices of Metals

June	Copper, N. Y., net refinery* Electrolytic	Tin 99 Per Cent	Tin Straits	Lead N. Y.	Lead St. L.	Zinc St. L.
1	13.625	30.75	31.875	5 65@5 75	5.50@5.55	5.275
2	13.625@13.75	31.25	32 00	5.65@5.75	5.50@5.60	5.275@5.30
3	13.625@13.75	31.25	32.00	5.65@5.75	5.50@5.60	5.30
5	13.625@13.75	31.50	32 25	5.65@5.80	5.50@5.60	5.30@5.35
6	13.625@13.75	31.625	32.625	5.65@5.80	5.50@5.60	5.35
7	13 625@13.75	31.375	32.375	5.75@5.80	5.50@5.60	5.35@5.375

*These prices correspond to the following quotations for copper delivered: June 1, 13.875c.; June 2 to 7 inc., 13.875@14c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Tin is quoted on the basis of spot American tin, 99 per cent grade, and spot Straits tin. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

June	Copper Standard Spot	Copper Standard 3M	Copper Electrolytic	Tin Spot	Tin 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
1	63¼	63½	69½	153¼	154½	25	23⅜	28⅛	27¼
2	63⅜	63¾	69½	154	155¼	24⅞	23¾	28⅛	27⅜
3	....	....	....	....	....	....	....	....	....
5	....	....	....	....	....	....	....	....	....
6	63⅛	63½	69½	154¾	155⅞	24⅞	23¾	28⅛	27⅜
7	62⅞	63¼	69½	154⅜	155½	25	23⅞	28	27¾

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver and Sterling Exchange

June	Sterling Exchange "Checks"	Silver New York Domestic Origin	Silver New York Foreign Origin	Silver London	June	Sterling Exchange "Checks"	Silver New York Domestic Origin	Silver New York Foreign Origin	Silver London
1	444⅝	99⅛	71¾	36¼	5	448½	99⅝	71⅜	....
2	446	99⅛	71¾	36⅛	6	450½	99⅝	70⅞	35½
3	447⅜	99⅛	71¼	35⅞	7	450	99⅛	71⅜	35⅜

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths of a cent premium.

Metal Markets

New York, June 7, 1922

Metal prices have continued to advance during the last week, though the market has not been a particularly active one. The gradual improvement is a reflection of better general business conditions, which have caused surplus metal stocks to be slowly absorbed, and which are likely to continue. Monday was a holiday in Europe, so that foreign business on that day was at a standstill.

Copper

Sales have been in moderate volume during the week, with three or four orders approaching a thousand tons each. Demand has for the most part been for July-August delivery, though September copper has also been sold. Practically all consumers seem to be well supplied for the current month, but, on the other hand, most of the producers have no more near-by metal available. Those that have are anxious sellers and would be willing to shade prices slightly under the quotations made for later deliveries. During the entire week, copper was obtainable for 13⅞c., especially by those consumers situated near New York and willing to take June or July deliveries. However, some of the producers who raised their price to 14c. have been able to book orders of fair proportions at that level. It is significant that although business has not been so active as it was some weeks ago, there seems no tendency so far for the price to recede; it has merely not advanced quite so rapidly.

The foreign orders were held up somewhat by the holiday, but export demand for the week was of fair proportions nevertheless. The prices realized were about one-quarter of a cent above those for domestic deliveries. Most of the metal was booked for June and July delivery.

Lead

The official contract price of the American Smelting & Refining Co. was advanced today from 5.65c. to 5.75c., New York.

Demand for lead at the advancing prices keeps up wonderfully well. Supplies have been carefully sold, and it has been difficult to obtain lead for speculative holding either by dealers or consumers. For this reason, any prolonged lull in demand is unlikely, for lead continues to go rapidly into consumption, and demand from every lead-consuming trade is excellent, or excellent compared with last year. Even chemical sheet lead sales have been more satisfactory recently. Corroders continue to run to the capacity of their plants.

In the New York district, reputable consumers were fairly generously supplied at 5.65c., at least until Monday. In the last day or two orders assumed such large proportions that the market was pretty well cleaned up of all metal held at less than 5.75c. Spot lead commanded even higher prices. In the St. Louis district, lead is still obtainable at 5.50c., a pronounced effort being made by one producer to hold the market at that level for a time rather than to let prices advance so rapidly that an undesirable reaction will follow. Dealers are, however, having difficulty in obtaining lead for less than 5.60 to 5.65c.

Desilverized lead is commanding a premium of about 10 points in the Middle West, where supplies of chemical lead are still abundant. In the vicinity of the Eastern seaboard, however, chemical lead is selling at the freight differential over St. Louis prices, which brings the delivered price somewhat above that for which the desilverized article can be obtained.

Zinc

Demand has improved somewhat from galvanizers, and with consumption continuing considerably above production, prices have advanced further. There is so far little disposition for custom smelters to increase production, owing

to the fact that ore prices have advanced so fast that smelting continues to be virtually a profitless operation. High-grade zinc continues to be in excellent demand at the same price as quoted last week—6¾c. with a 30-point freight allowance. The New York market continues at the customary advance of 35 points over St. Louis quotations, this representing the freight.

Tin

Tin has advanced slightly in London, but the higher prices here are caused chiefly by the advance in sterling exchange. Demand has been good, and practically all of the spot metal available has now been taken up. Reports from Pittsburgh indicate that the tinplate mills are working practically at full capacity. American electrolytic tin is in good demand from tinfoil makers and others at the same prices quoted for Straits. Tin of 99 per cent grade is rather scarce for some of the better grades. However, Chinese No. 1 tin, which is a good 99 per cent grade, is now available again with the higher prices, several houses with Chinese connections making offerings.

Tin for September delivery sold at ¼c. to ⅜c. discount from the quotations for spot.

Arrivals of tin, in long tons: Total for May, Atlantic ports, 4,600; Pacific ports, 140. June 1st, Straits, 925; Liverpool, 50; Australia, 15; 5th, London, 25; China, 5.

Gold

Gold in London: June 1st, 93s. 1d.; 2d, 92s. 11d.; 6th, 92s. 1d.; 7th, 91s. 6d.

Foreign Exchange

Sterling exchange reached new high levels during the last week, the highest since it was released from control following the World War. The strength in sterling also affected other foreign exchanges favorably. On Tuesday, June 6, francs were 9.135c.; lire, 5.215c.; marks, 0.3425c.; and Canadian dollars, 99.16c., the highest point yet reached.

Silver

The first week of June showed a continued fall in silver prices, owing to lack of support from China and India, although the advance in sterling rates helped to steady the market in New York. On the 6th silver in San Francisco and New York was on about the same level, showing the weakness of China exchanges. The market closes quiet, without pronounced tendency, and the future depends upon China.

Mexican Dollars—June 1st, 54⅞; 2d, 54⅞; 3d, 54½; 5th, 54⅝; 6th, 54¼; 7th, 54½.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—20c. per lb. for 99 per cent grade; 19c. for 98@99 per cent; 18c. for 94@98 per cent. Outside market nominal at 17.25@18.25c. for 98@99 per cent virgin grades.

Antimony — Chinese and Japanese brands, 5.25@5.30c. W.C.C., 6@6¼c. Cookson's "C" grade, spot, 8.75c. Chinese needle antimony, lump, nominal, 3.5@4c. per lb. **Standard powdered needle antimony (200 mesh) nominal at 5¼c. per lb. White antimony oxide,** Chinese, guaranteed 99 per cent Sb_2O_3, 6.75@7c.

Bismuth—$2@$2.10 per lb.

Cadmium—$1.15@$1.20 per lb.

Iridium—Nominal, $150@$170 per oz.

Nickel—Standard market, ingot and shot, 36c.; electrolytic, 39c. Outside market quiet at 29@32c. per lb.

Palladium—$55 per oz.

Platinum—$85@$87.50 per oz.

Quicksilver—$55 per 75-lb. flask. San Francisco wires $54.

The prices of **Cobalt, Magnesium, Molybdenum, Monel Metal, Osmium, Rhodium, Selenium, Thallium and Tungsten** are unchanged from the prices in the issue of June 3.

Metallic Ores

Chrome, Iron, Magnetite, Manganese, Molybdenum, Tantalum, Titanium, Tungsten, Uranium, Vanadium, and Zircon ores are unchanged from the quotations published June 3.

Zinc and Lead Ore Markets

Joplin, Mo., June 3—Zinc blende, per ton, high, $33.05; basis 60 per cent zinc, premium, $32; Prime Western, $32@$31; fines and slimes, $29@$28; average settling price, all blende, $29.64. Calamine, basis 40 per cent zinc, $15.

Lead, high, $73.60; basis 80 per cent lead, $70@$75; average settling price, all lead ore, $71.30 per ton.

Shipments for the week: Blende, 11,861; calamine, 69; lead, 1,585 tons. Value, all ores the week, $465,690.

Sellers held firm and secured advances in all grades of blende. Premium grades and some ore high in iron sold on $32 basis. The demand continues strong, the purchase exceeding the production. Careful survey of the situation points to only one week's supply of purchasable ore ahead of the production. At present 106 mills are in operation and the output is around 10,500 to 11,000 tons per week.

Lead was in stronger demand this week, with some ore selling on $75 basis. The production is less than the demand, which creates sharp competition among buyers.

Platteville, Wis., June 3—Blende, basis 60 per cent zinc, $32 per ton. Lead ore, basis 80 per cent lead, $75 per ton. Shipments for the week: Blende, 297 tons; lead, 40 tons. Shipments for the year: Blende, 6,704 tons; lead ore, 977 tons. Shipped during the week to separating plants, 713 tons blende.

Non-Metallic Minerals

Talc—High-grade foundry talc, $20 per ton, or $18 in carload lots, f. o. b. Virginia mills. Demand better.

Asbestos, Barytes, Bauxite, Borax, Chalk, China Clay, Emery, Feldspar, Fluorspar, Fuller's Earth, Graphite, Gypsum, Limestone, Magnesite, Mica, Monazite, Phosphate, Pumice, Pyrites, Silica, Sulphur, and **Talc** are unchanged from the prices published in the June 3 issue.

Mineral Products

Arsenious Oxide—7@7.25c. per lb.

Copper Sulphate—6.15@6.25c. for large crystals. Prompt shipment scarce.

Potassium Sulphate, Sodium Nitrate, and **Sodium Sulphate** are unchanged from quotations of June 3.

Ferro-Alloys

Ferrocerium, Ferrochrome, Ferromanganese, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium, and **Ferrovanadium** are unchanged from the prices published June 3.

Metal Products

Copper Sheets—New York base, 20.50c. per lb.; wire, 15.75c.

Nickel Silver—26.75c. per lb, for 18 per cent nickel Grade "A" sheets.

Yellow Metal—Dimension sheets, 17.75c.; rods, 14.75c. per lb.

Lead Sheets and **Zinc Sheets** are unchanged from the quotations published in the June 3 issue.

Refractories

Bauxite Brick, Chrome Brick, Chrome Cement, Firebrick, Magnesite Brick, Magnesite Cement, Silica Brick, and **Zirkite** are unchanged from the prices appearing in the issue of June 3.

The Iron Trade

Pittsburgh, June 6, 1922

Production of steel ingots continues at a rate of about 38,000,000 tons a year. It is commonly believed that a considerable part of the steel demand in the past few months has been due to buyers fearing that the coal strike would interfere with deliveries. While up to date steel production has been at an increased rate, the coal strike does not appear to be any nearer settlement than when it started. The steel mills, on an average, are fully sold up for about two months at their present production rate.

Last Friday the American Sheet & Tin Plate Co. opened its order books for new periods at former prices, $4.75 for tin plate, 2.40c. for blue annealed sheets, 3.15c. for black sheets, 4.15c. for galvanized sheets, and 4.50c. for automobile sheets, but in sheets orders for July only are taken. Some independents are now selling for later deliveries at slight advances. Bars, shapes and plates are 1.60c. minimum, with early deliveries commanding premiums.

Pig Iron—The market continues absolutely stagnant, appraised values being $25, Valley, for bessemer and basic and $24 for foundry. Lake Superior iron ore prices for the 1922 season have not yet been developed.

Coke

Connellsville Coke—Offerings and demand are both light, prices being about $7 for furnace and $7.50 for foundry coke.

COMPANY REPORTS

Anaconda Copper Mining Co.

The Anaconda ceased production of copper about April 1, 1921, owing to the industrial depression, and remained closed down for the remainder of the year, operations being resumed Jan. 16, 1922. The complete financial report for the Anaconda and subsidiary companies follows:

CONSOLIDATED BALANCE SHEET, DEC. 31, 1921

ASSETS

Fixed		
Mines and mining claims, rights and lands	$119,438,110.62	
Buildings and machinery	76,285,549.17	
Investments in sundry companies	16,496,444.04	
		$212,220,103.83
Current		
Supplies on hand, advances on ores and expenses prepaid	$21,989,306.50	
Metals and manufactured products in process and on hand—at the lower of cost or market	17,817,363.59	
Accounts receivable and cash assets	21,235,831.13	61,042,501.22
		273,262,605.05

LIABILITIES

Issued capital stock, 2,331,250—$25 shares		$116,562,500.00
Minority interests in subsidiary companies		2,486,295.12
Outstanding ten-year gold bonds due Jan 1, 1929		49,201,700.00
Reserve for depreciation		24,182,834.37
Current		
Accounts and wages payable, and taxes and interest accrued		13,075,368.31
Surplus		
Balance Dec. 31, 1920	$84,753,462.44	
Net loss for the year ending Dec. 31, 1921	16,999,555.19	67,753,907.25
		$273,262,605.05

CONSOLIDATED INCOME ACCOUNT

EXPENSE

Metals and manufactured products in process and on hand at beginning of year		$36,516,880.05
Mining, including development		3,786,076.51
Ore purchases		3,957,200.16
Reduction, including transportation of ore		5,119,253.62
Refining and selling, including transportation of metals		1,250,676.43
Manufacturing expense, including selling		5,337,188.60
Administration and Federal taxes		1,220,361.50
		$57,187,636.87
Balance brought down		6,257,042.38
Amount charged off this year for depreciation and obsolescence		2,135,401.31
Interest, including discount on bonds		3,108,267.89
Expenditure during suspension of operations		5,680,503.39
		$17,181,214.97

INCOME

Sales of metals and manufactured products		$31,097,213.90
Royalties, tolls, rentals		2,016,017.00
Metals and manufactured products in process and on hand at the end of year		17,817,363.59
Balance carried down		6,257,042.38
		$57,187,636.87
Income from investments in sundry companies		$ 120,025.78
Balance, net loss		
Apportioned to minority interests	$61,634.00	
Carried to foregoing balance sheet	16,999,555.19	
		17,061,189.19
		$17,181,214.97

Purchase of the American Brass Co. was consummated Feb. 10, 1922, when more than 99 per cent of the Brass shares were acquired. An outstanding feature of the year was the development of the Anaconda metal shingle, to be made of copper or zinc. This was perfected in October, an operating plant and selling organization afterward developed, and the product is now being marketed.

In the copper department, 353,055 wet tons of ore were produced at the company's mines at Butte, Mont., and 373,410 tons were treated at the Anaconda concentrator.

The operations of the company include copper mines at Butte, a concentrator and smelter at Anaconda; refineries at Great Falls, Mont., and Raritan, N. J.; and a rod and wire mill at Great Falls. There are zinc mines at Butte, and reduction works at Anaconda and Great Falls. Miscellaneous products include lumber from sawmills at Bonner and Hope; coal from Diamondville, Wyo., Washoe, Mont., and Sand Coulee, Mont.; arsenious oxide; sulphuric acid from Anaconda; and fertilizer, the phosphate rock coming from mines at Conda, Idaho. Subsidiary companies include the Butte, Anaconda & Pacific Ry. Co.; the International Smelting Co. at International, Utah, and Miami, Ariz.; the International Lead Refining Co. at East Chicago, Ind.; the Anaconda Lead Products Co.; the Walker Mining Co.; the Arizona Oil Co.; and in South America, the Andes Copper Mining Co.; the Potrerillos Ry., and the Santiago Mining Co.

As is customary, the report fails to reveal to stockholders any technical details or costs of the company's operations.

Bunker Hill & Sullivan

The profit-and-loss analysis of the Bunker Hill & Sullivan Mining & Concentrating Co., operating at Kellogg, Idaho, for the year ending Dec. 31, 1921, is as follows:

DEBIT

		Per Ton Concentrates Produced	
Production costs (89,923 tons mill product)			
Mining, 426,530 tons mined		$15.18	$1,364,669
Milling, West Mill, 438,526 tons mine ore	$348,214		
Sweeney Mill, 153,820 tons tailings	70,844	4.66	419,059
Shipping expense, 89,746 tons concentrates shipped		.26	22,960
Smelting costs:			
Freight and treatment, and lead and silver discounts (on ore shipped)		21.32	1,916,850
South Mill expense		.04	4,079
North Mill experimental		.30	27,003
Mine examinations		1.77	159,443
Interest paid on bank loans		.14	12,339
Worthless accounts and notes charged off		.07	5,958
Stores inventory adjustment		.03	3,200
		$43.77	$3,935,565

CREDIT

		Per Ton Concentrates Produced	
Bullion			
Gross lead and silver value of product shipped	$4,602,349		
Less concentrates inventory adjustment at cost	4,371		
		51.13	$4,597,978
Royalties on lessees' ore		.27	24,214
Net profit of light and water dept.		.01	529
Net profits on house rentals		.02	1,490
West Mill rentals		.12	10,291
Tramway rentals		.01	813
Dividends			
Caledonia Mining Co.	$13,081		
Sierra Nevada Consolidated Mining Co.	240,918		
		2.82	253,999
Interest			
On loans and accounts	$34,873		
On bonds and other reserve securities	99,315	1.49	134,188
Sale of securities, net profit		.28	25,199
		$56.15	$5,049,335
Add: Bunker Hill smelter, net profit after depreciation		3.63	326,787
		$59.78	$5,376,122

The balance for the year carried to Surplus was $804,305.

The report gives complete cost data. The mining cost was $3.17, some of the principal items being: timber and lagging, 45c.; shovelers, 39c.; timbermen and carpenters, 26c.; miners, 22c.; compressed air, 16c.; machinemen, 13c.; and powder, 10c. Exploration cost $16.81 per foot; stoping, $2.02 per ton; tramming, 8c. per ton; hoisting, 7c. per ton; and pumping, 8c. per ton.

Concentration cost 79c. per ton, including 8c. for crushing and conveying; 4c. for screening; 9c. for jigging; 7c. for tube-mill grinding; and 18c. for concentration, including 7c. flotation royalty.

Alaska Juneau Gold Mining Co.

A report of the operations of the Alaska Juneau Gold Mining Co. for 1921 shows a loss of $168,731.84, according to the following profit-and-loss analysis:

DEBITS		
Mining	$322,298.17	
Milling	573,414.32	
Marketing concentrates and bullion	45,620.02	
General, legal expense and taxes	61,919.81	
Storm slide damage	14,896.21	
Stock transfer expense	3,310.50	
Bond issue expense	533.82	
Bond interest	126,424.62	
Interest on note and loan accounts	57,696.97	
		$1,206,114.44
CREDITS		
Bullion production (from amalgamation)	$797,074.57	
Gold recovery $789,467.26		
Silver recovery 7,607.31		
Concentrates production	238,176.08	
Gold recovery $180,235.47		
Silver recovery 32,764.08		
Lead recovery 25,176.53		
Liability	1,917.95	
Assumed on pay rolls $12,321.03		
Less cost of accident settlements 10,403.08		
Revenue from rents	214.00	
		1,037,382.60
Net loss for year—to surplus account		$168,731.84
SURPLUS		
Dec. 31, 1920, balance per account, deficit		563,624.69
Dec. 31, 1921, balance per account, deficit		732,356.53

Balance sheet as of Dec. 31, 1921, follows:

ASSETS		
Property		$9,639,844.68
Mine development		1,965,322.33
Construction and equipment—main plant		3,333,592.68
Portable and underground equipment		49,208.14
Deferred charges to future operations		514,670.75
Supplies		325,114.73
Production in transit		130,027.86
Cash accounts		18,692.07
Sundry accounts receivable		2,650.93
Deficit in surplus account		732,356.53
		$16,711,480.70
LIABILITIES		
Capital stock, authorized, 1,500,000 shares at $10.00		
Par value $15,000,000		
Less unissued, 100,000 shares 1,000,000		
		$14,000,000.00
Notes payable—6 per cent guaranteed notes		460,000.00
Bond issue, 7 per cent 10 year gold bonds, authorized $3,500,000		1,836,000.00
Bond coupons not presented for payment		87,554.16
Loan accounts and advances against current production—interest bearing		205,991.83
Pay roll and accounts payable, and other liabilities		102,202.12
Depreciation reserve		19,732.59
		$16,711,480.70

Costs were $0.1997 for mining; $0.3554 for milling; $0.1910 for other costs; total, $0.7461 per ton trammed. Production was $0.6416 per ton.

Fairview Round Mountain Mines Co.

The annual report of the Fairview Round Mountain Mines Co., with properties at Round Mountain, Nye County, Nev., states that the leasing operations carried on in 1921 were highly successful and resulted in opening up more and richer ore than was expected.

The balance sheet is as follows, as of Dec. 31, 1921:

ASSETS	
Mining properties	$989,075.97
Mining properties (discovery valuation)	303,171.90
Bonds and stocks	59,293.32
Mine and mill plants and equipment	20,272.25
Store supplies	1,421.28
Accounts receivable	39,077.80
Bills receivable	32,000.00
Cash on hand	2,929.96
	$1,447,242.48
LIABILITIES	
Capital	$1,000,000.00
Profit and loss	41,632.75
Bills payable	7,500.00
Dividends uncalled for	4,951.73
Discovery valuation surplus	7,982.68
Ore depletion reserve	385,175.32
	$1,447,242.48

Movements of Ores and Metals for April

Imports and exports of the more important metals and ores during April, 1922, and April, 1921, as prepared by the U. S. Bureau of Foreign and Domestic Commerce, are as follows:

IMPORTS

In Pounds, Unless Otherwise Stated

	April, 1921	April, 1922
Antimony ore, contents	26,400	.....
Antimony matte and regulus	2,710,581	986,465
Copper		
Ore, contents	2,086,083	7,764,694
Concentrates, contents	3,647,147	1,676,411
Matte and regulus, contents	805,775	1,375,591
Total	6,539,005	10,816,696
Imported from		
Spain	274,870	1,099,481
Canada	252,677	754,786
Mexico	2,636,950	870,035
Cuba	1,375,104	2,620,660
Chile	832,388	5,143,377
Peru	18,457	69,492
Other countries	1,148,559	258,865
Unrefined, black and blister	10,109,145	19,015,875
Refined, in ingots and bars	19,070,079	6,760,243
Old, for remanufacture	389,339	2,966,060
Composition metal, copper chief value	.....	39,927
Lead		
Ore, contents	988,534	1,646,019
Bullion, contents	11,380,892	3,602,232
Imported from		
Canada	496,181	48,085
Mexico	11,562,680	3,837,468
Chile	234,627	736,689
Other countries	75,938	626,009
Pigs, bars and old	4,558,440	170
Manganese ore, long tons	47,260	25,559
Imported from		
Cuba	.....	23
Brazil	31,350	13,700
British India	14,910	6,250
Other countries	1,000	5,586
Sulphur ore, as pyrites, long tons	24,059	30,480
Imported from		
Spain	21,609	30,480
Other countries	2,450	.....
Tin ore, long tons	607	1,359
Tin bars, blocks and pigs	2,483,655	10,526,046
Imported from		
United Kingdom	605,203	1,455,991
British Straits Settlements	1,814,441	8,564,510
Dutch East Indies	.....	55,971
Hongkong	43,838	449,574
Other countries	20,173	.....
Tungsten ore, long tons	109	.....
Zinc		
Ore, contents	88,283	.....
Imported from:		
Mexico	88,283	.....
Blocks, or pigs and old	6,269,176	78

EXPORTS OF COPPER, LEAD AND ZINC

In Pounds

	April, 1921	April, 1922
Copper		
Ore, concentrates, contents	167,900	7,168
Unrefined, black and blister	.....	112,030
Refined, in ingots and bars	40,256,030	62,196,959
Exported to (in part)		
Belgium	999,358	4,106,706
France	10,800,273	13,956,127
Germany	15,837,896	17,983,470
Italy	223,915	3,789,074
Netherlands	1,166,600	2,713,069
Spain	.....	1,151,654
United Kingdom	7,976,634	3,914,443
Canada	1,541,713	265,219
Composition metal, copper chief value	68	9,803
Old and scrap	40	88,368
Pipes and tubes	184,046	196,084
Plates and sheets	342,813	590,378
Wire, except insulated	711,858	2,217,709
Lead		
Pigs, bars, etc.		
Produced from domestic ore	136,641	1,511,657
Produced from foreign ore	448,077	4,864,938
Exported to		
United Kingdom	.....	2,634,283
Canada	18,983	119,980
Argentina	224,077	809,232
Brazil	.....	430,188
Japan	224,000	112,000
Other countries	117,658	2,270,912
Zinc		
Dross	.....	2,308,847
Spelter		
Produced from domestic ore	115,838	4,542,824
Produced from foreign ore	.....	448,000
Exported to:		
France	.....	2,167,732
Italy	.....	112,045
United Kingdom	.....	1,189,051
Canada	.....	58,258
Mexico	2,618	143,119
Argentina	220	56,000
Japan	112,000	1,064,094
Other countries	1,000	200,525
In sheets and strips	388,412	582,531

MINING STOCKS

Week Ended June 3, 1922

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Ahmeek	Boston	66	64	65	Sept. '20, Q	$0.50
Alaska-Br. Col. new.	N. Y. Curb	5⅜	4⅞	4⅞	.....	....
Alloues	Boston	29	28	29	Mar. '19	1.00
Anaconda	New York	57	56	56	Nov. '20, Q	1.00
Arcadian Consol.	Boston	4¾	4½	4½	.....	....
Ariz. Com'l	Boston	10⅜	10	10	Oct. '18, Q	0.50
Big Ledge	N. Y. Curb	*22	*20	*20	.....	....
Bingham Mines	Boston	15¼	15⅛	15⅛	Sept. '19, Q	0.25
Calumet & Arizona	Boston	66	63½	65⅛	Mar. '22, Q	0.50
Calumet & Hecla	Boston	298	288	288	June '20, Q	5.00
Canada Copper	N. Y. Curb	*42	*38	*38	.....	....
Centennial	Boston	12	12	12	Dec. '18, SA	1.00
Cerro de Pasco	New York	40⅝	39½	39½	Mar. '21, Q	0.50
Chile Copper	New York	23⅜	22½	22⅛	.....	....
Chino	New York	33⅜	31½	33¼	Sept. '20, Q	0.37½
Columbus Rexall	Salt Lake	*29	*29	*29	.....	....
Con. Arizona	N. Y. Curb	*5	*5	*5	Dec. '18, Q	0.05
Con. Copper Mines	N. Y. Curb	1⅛	1⅛	1⅛	.....	....
Copper Range	Boston	46⅜	45½	45½	Mar. '22, Q	1.00
Crystal Copper	Boston Curb	1⅛	1⅛	1⅛	.....	....
Davis-Daly	Boston	8 1/16	8⅛	8⅛	Mar. '20, Q	0.25
East Butte	Boston	12	11¼	11¼	Dec. '19, A	0.50
First National	Boston Curb	*75	*70	*70	Feb. '19, SA	0.15
Franklin	Boston	2⅛	2⅛	2⅛	.....	....
Gadsden Copper	Boston Curb	1¼	1	1¼	.....	....
Granby Consol	New York	34⅜	32½	32⅞	May '19, Q	1.25
Greene-Cananea	New York	34⅜	34	34¼	Nov. '20, Q	0.50
Hancock	Boston	3	3	3	.....	....
Howe Sound	N. Y. Curb	3⅜	3½	3½	Jan. '21, Q	0.05
Inspiration Consol	New York	45	43⅜	44⅜	Oct. '20, Q	1.00
Iron Cap	Boston Curb	8½	7⅞	8	Sept. '20, K	0.25
Isle Royale	Boston	26½	25	26⅛	Sept. '19, SA	0.50
Kennecott	New York	39⅝	38⅝	38⅛	Dec. '20, Q	0.50
Keweenaw	Boston	3	1⅞	2⅞	.....	....
Lake Copper	Boston	5¾	4⅛	5	.....	....
La Salle	Boston	†2	†1¾	1⅞	.....	....
Magma Copper	N. Y. Curb	31⅜	31	31	Jan. '19, Q	0.50
Majestic	Boston Curb	*10	*10	*10	.....	....
Mason Valley	Boston	2½	2½	2½	.....	....
Mass. Consolidated	Boston	3⅛	3	3¼	Nov. '17, Q	1.00
Miami Copper	New York	31⅛	30⅝	31	May '22 Q	0.50
Michigan	Boston	3⅛	3	3⅛	.....	....
Mohawk	Boston	67½	66	67½	Feb. '22, Q	1.00
Mother Lode Coa	N. Y. Curb	10⅛	9⅞	9⅞	.....	....
Nevada Consol	New York	19⅜	18⅝	18⅝	Sept. '20, Q	0.25
New Cornelia	Boston	20½	19⅜	20⅛	May '22, K	0.25
North Butte	Boston	15	14¼	14⅜	Oct. '18, Q	0.25
North Lake	Boston	⅛	⅛	⅛	.....	....
Ohio Copper	N. Y. Curb	*10	*10	*10	.....	....
Old Dominion	Boston	27	26	27	Dec. '18, Q	1.00
Osceola	Boston	38	36	36½	June '20, Q	0.50
Phelps Dodge	Open Mar.	†185	†175	...	Apr. '22, Q	1.00
Quincy	Boston	50	48½	49¼	Mar. '20, Q	1.00
Ray Consolidated	New York	19	18⅛	18⅛	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	2	1⅞	1⅞	.....	....
St. Mary's Min. Ld.	Boston	48½	47	47½	Apr. '22, K	2.00
Seneca Copper	Boston	14	14	14	.....	....
Shannon	Boston	1⅛	*95	*95	Nov. '17, Q	0.25
Shattuck Arizona	New York	12	10⅜	11⅜	Jan. '20, Q	0.25
South Lake	Boston	1⅛	1⅛	1⅛	.....	....
Superior & Boston	Boston	1⅛	1⅛	1⅛	.....	....
Tenn. C. & C. cfs	New York	12⅜	12⅜	12½	May '18, I	1.00
Tuolumne	Boston	*85	*80	*80	May '13,	0.10
United Verde Ex.	Boston Curb	31	29	30	May '22, Q	0.25
Utah Consol	Boston	3⅛	2⅞	3⅛	Sept. '18,	0.25
Utah Copper	New York	69¼	67⅞	68⅜	Mar. '22, Q	0.50
Utah Metal & T	Boston	1⅝	1½	1½	Dec. '17,	0.30
Victoria	Boston	2	2	2	.....	....
Winona	Boston	2	1⅞	1 15/16	.....	....
Wolverine	Boston	16	15	15	.....	....
NICKEL-COPPER						
Internat. Nickel	New York	18½	17¾	18	Mar. '19,	0.50
Internat. Nickel, pfd	New York	†84	†79	80	May. '22, Q	1.50
LEAD						
National Lead	New York	96⅝	94½	95	Mar. '22, Q	1.50
National Lead, pfd	New York	110	109⅜	110	Mar. '22, Q	1.75
St. Joseph Lead	New York	15⅜	15	15⅛	Mar. '22, Q	0.25
QUICKSILVER						
New Idria	Boston	†1½	†1	1⅛	.....	....
ZINC						
Am. Z. L. & S	New York	20⅜	19½	19½	May '20,	1.00
Am. Z. L. & S. pfd	New York	48	47	48	Nov. '20, Q	1.50
Butte C. & Z	New York	8	7⅜	7⅜	June '18,	0.50
Butte & Superior	New York	33⅜	32	32⅜	Sept. '20,	1.25
Callahan Zn-Ld	New York	11⅛	10½	10⅝	Dec. '20, Q	0.50
New Jersey Zn	N. Y. Curb	144½	143⅜	144	May '22, Q	2.00
Yellow Pine	Los Angeles	*53	*53	*54	Sept. '20, Q	0.03

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	⅛	⅛	⅛	.....	....
Alaska Juneau	New York	1¼	1⅛	1⅛	.....	....
Carson Hill	New York	†15	†12	15	.....	....
Cresson Consol. G	N. Y. Curb	2 3/16	2⅛	2 3/16	Apr. '22, Q, X	$0.10
Dome Extension	Toronto	...	...	1	.....	....
Dome Mines	New York	29½	28⅛	29½	Apr. '22, Q	1.00
Florence Goldfield	N. Y. Curb	*20	*18	*18	.....	....
Golden Cycle	Colo. Springs	*79	*76½	*76½	June '21, Q	0.02
Goldfield Consol	N. Y. Curb	*8	*7	*8	Dec. '19,	0.05
Hollinger Consol	Toronto	9.70	9.65	9.70	May '22,	0.05
Homestake Mining	New York	70	70	70	May '22, M	0.25
Kirkland Lake	Toronto	*40	*39	*40	.....	....
Lake Shore	Toronto	2.33	2.25	2.30	Nov. '21, K	0.02
McIntyre-Porcupine	Toronto	18.25	19.75	18.00	May '22, K	0.05
Porcupine Crown	Toronto	*26½	*26	*26½	July '17,	0.03
Porcupine V. N. T	Toronto	*27½	*23½	*24½	.....	....
Portland	Colo. Springs	*27	*25	*25	Oct. '20, Q	0.01
Schumacher	Toronto	*65½	*63	*64	.....	....
Silver Pick	N. Y. Curb	...	...	*9	.....	....
Teck Hughes	Toronto	*54	*51	*52	.....	....
Tom Reed	Los Angeles	*65	*60	*65	Dec. '19,	0.02
United Eastern	N. Y. Curb	1 13/16	1⅝	1 13/16	Apr. '22, Q	0.15
Vindicator Consol	Colo. Springs	*8	*7	*7	Jan. '20, Q	0.01
White Caps Mining	N. Y. Curb	*9	*8	*9	.....	....
Wright-Hargreaves	Toronto	3.75	2.60	3.75	Apr. '22,	0.02½
Yukon Gold	N. Y. Curb	1	*90	*90	June '18,	0.02½
SILVER						
Batopilas Mining	New York	1⅛	1	1⅛	Dec. '07, I	0.12½
Beaver Consol	Toronto	*34	*30	*33	May '20, K	0.03
Coniagas	Toronto	1.25	1.20	1.25	May '21, Q	0.12½
Crown Reserve	Toronto	*17½	*15½	*17½	Jan. '17,	0.05
Kerr Lake	N. Y. Curb	3½	3⅜	3⅜	Apr. '22, Q	0.12½
La Rose	Toronto	*33	*30	*31	Apr. '22,	0.10
McKinley-Dar.-Sav	Toronto	*28½	*27	*28	Oct. '20, Q	0.03
Mining Corp. Can	Toronto	1.05	1.00	1.05	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	6½	6¼	6⅜	Apr. '22, Q, X	0.30
Ontario Silver	New York	8½	7⅞	8½	Jan. '19, Q	0.50
Ophir Silver	N. Y. Curb	...	...	*12	Jan. '12,	0.10
Temiskaming	Toronto	*35	*29	*30	Jan. '20, K	0.04
Trethewey	Toronto	*4	*3½	*3½	Jan. '19,	0.05
GOLD AND SILVER						
Boston & Montana	N. Y. Curb	*21	*19	*20	.....	....
Cash Boy	N. Y. Curb	*7	*5	*7	.....	....
Dolores Esperanza	N. Y. Curb	2⅞	2½	2⅞	.....	....
El Salvador	N. Y. Curb	*6	*5	*5	.....	....
Jim Butler	N. Y. Curb	...	...	*7	Aug. '18, SA	0.07
Jumbo Extension	N. Y. Curb	*6	*5	*5	June '16,	0.05
MacNamara M.&M.	N. Y. Curb	*8	*6	*8	May '10,	0.02½
Tonopah Belmont	N. Y. Curb	1 13/16	1⅝	1 13/16	Apr. '22, Q	0.05
Tonopah Divide	N. Y. Curb	*82	*77	*79	.....	....
Tonopah Extension	N. Y. Curb	1⅞	1⅝	1 13/16	Apr. '22, Q	0.05
Tonopah Mining	N. Y. Curb	1⅝	1⅝	1⅝	Apr. '22, SA, X	0.07½
West End Consol	N. Y. Curb	1 1/16	1 1/16	1⅛	June '22, SA	0.05
SILVER-LEAD						
Caledonia	N. Y. Curb	*10	*10	*10	Jan. '21, M	0.01
Cardiff M. & M	Salt Lake	†*96	†*93	*94	Dec. '20,	0 15
Chief Consol	Boston Curb	4 1/16	4¼	4 3/16	May '22, Q	0.05
Consol. M. & S	Montreal	24	24	24	Oct. '20, Q	0.62½
Daly Mining	Salt Lake	†2.00	†1.45	...	July '20, Q	0.10
Daly-West	Boston	2⅛	2⅛	2⅛	Dec. '20, Q	0.25
Eagle & Blue Bell	Boston Curb	3	3	3	Apr. '21, K	0.05
Electric Point	Spokane	*8½	*7	*7½	May '20, SA	0.03
Federal M. & S	New York	14½	14½	14½	Jan '09,	1.50
Federal M. & S. pfd.	New York	52½	50½	50½	Mar. '22, Q	1.00
Florence Silver	Spokane	*23	*23	*23	Apr. '19,	0.01½
Grand Central	Salt Lake	*60	*60	*60	Jan. '21, K	0.01
Hecla Mining	N. Y. Curb	6½	6⅜	6½	Mar. '22, Q	0.15
Iron Blossom Con	N. Y. Curb	*23	*22	*22	Apr. '22, Q	0.02½
Judge M. & S	Salt Lake	†2.50	†2.20	2.60	Sept. '20, Q	0.12½
Marsh Mines	N. Y. Curb	*32	*24	*28	June '21, I	0.02
Prince Consol	Salt Lake	*5½	*5⅛	*5½	Nov. '17,	0.02½
Rambler-Cariboo	Spokane	*7	*6	*6½	Feb. '19,	0.01
Rex Consol	N. Y. Curb	*11	*10	*11	.....	....
South Hecla	Salt Lake	†*60	†*35	...	Sept. '19, K	0.15
Standard Silver-Ld	N. Y. Curb	*21	*20	*20	Oct. '17,	0.05
Stewart Mines	N. Y. Curb	*10	*7	*9	Dec. '15,	0.05
Tamarack-Custer	Spokane	2 74	2.45	2.47	Jan. '21, K	0.04
Tintic Standard	Salt Lake	2.12½	2.07½	2.10	Dec. '21, Q	0.05
Utah Apex	Boston	3⅛	3	3⅛	Nov. '20, K	0.25
Wilbert Mining	N. Y. Curb	....	....	*2	Nov. '17,	0.01
VANADIUM						
Vanadium Corp	New York	51⅛	49	50	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp	Montreal	56	56	56	Apr. '22, Q	1.50
Asbestos Corp. pfd	Montreal	....	....	75½	Apr. '22, Q	1.75
SULPHUR						
Freeport, Texas	New York	26⅞	21⅛	26⅜	Nov. '19, Q	1.00
Texas Gulf	New York	51⅛	46½	50½	Mar. '22, QX	1.00
MINING, SMELTING AND REFINING						
Amer. Sm. & Ref	New York	66⅛	65½	65⅛	Mar. '21, Q	1.00
Amer. Sm.& Ref. pf.	New York	98½	98	98½	June '22 Q	1.75
Am. Sm. Sec. pf. A	New York	†94	†93	93	Apr. '22, Q	1.50
U. S. Sm. R. & M	New York	45⅛	44⅛	44⅛	Jan. '21, Q	0.50
U.S. Sm.R.& M. pf.	New York	46⅛	45⅛	4 ⅛	Apr. '22, Q	1.75

*Cents per share. †Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra.

Toronto quotations courtesy Hamilton B. Wills; Spokane, Pohlman Investment Co; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Commerce and Oil; Colorado Springs, The Financial Press, N. Y.

Current Prices of Mine Materials and Supplies

RISE AND FALL OF THE MARKET

Advances—Track bolts and spikes up 10c. per 100 lb. at Birmingham. Cast-iron pipe advanced $2 per ton in New York and throughout West. Lumber advancing $1@$5 per M. ft. over country. Red and white lead, dry and in oil, up 25c. per 100 lb. Manila rope higher in South.

Declines.—Substantial reductions in bolts and nuts. Linseed oil market headed downward; decline of 3c. in New York and 5c. per gal. in Chicago. Dynamite cheaper in Southern and Southwestern states.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
Blue Annealed No. 10	$2.40	$3.62½	$3.38	$4.15	$3.48
Black No. 28	3.15	4.30	4.30	5.65	4.35
Galvanized No. 28	4.15	5.30	5.30	6.50	5.35

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots:

	Pittsburgh Current	Pittsburgh One Year Ago	Birmingham	Chicago
Standard bessemer rails	$40.00	$45.00	.....	$40.00
Standard openhearth rails	40.00	47.00	$40.00	40.00

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Current	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.25	$3.30	$2.55	$3.00	$4.10	$3.20
Track bolts	3.00@3.50	4.35	3.65	4.25	5.10	4.15
Standard section angle bars	2.40	2.50	2.40	3.00	4.00	3.25

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	1.60	$1.85	$2.58	$4.00	$2.57½	$2.48	$3.10
Channel, 3 to 15 in.	1.60	1.85	2.58	4.00	2.57½	2.48	3.10
Angles, 3 to 6 in., ¼ in. thick	1.60	1.85	2.58	4.00	2.57½	2.48	3.10
Tees, 3 in. and larger	1.60	1.85	2.58	4.00	2.57½	2.48	3.10
Plates	1.60	1.85	2.58	4.00	2.57½	2.48	3.10

WIRE ROPE—Discounts from list price, f.o.b. New York and east of Missouri River, on regular grades of bright and galvanized are as follows:

Hercules red strand, all constructions	30%
Cast steel round strand rope	32½%
Galvanized steel rigging and guy rope	17½%
Round strand iron and iron tiller	15%
Plow steel round strand rope	45%
Special steel round strand rope	40%

	New York	Cleveland	Chicago
Drill Rod (from list)	55@60%	55%	50%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

	Inches	Steel Black	Galv.	Inches	Iron Black	Galv.
BUTT WELD—	1 to 3	71	58½	⅜ to 1½	44½	29½
LAP WELD—	2½ to 6	68	55½	2½ to 6	42½	29½

STEEL PIPE—From warehouses at the places named the following discounts for hold steel pipe:

	Black New York	Black Chicago	Black St. Louis
2½ to 6 in. lap welded	61%	59½%	56%

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York Current	New York One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
6 in. and over*	$48.80@49.80	$58.30	$34.50	$44.10	$39.70	$51.00

	New York	Cleveland	Chicago
Nuts, hot pressed, sq., per 100 lb. Off list	$3.25	$3.50	$4.00
Nuts, cold punched, sq., per 100 lb. Off list	3.25	3.50	4.00

MACHINE BOLTS	New York	Cleveland	Chicago
1½ and 1¼x3 in. up to 12 in.	60%	60–10–10%	60-10%
Button head bolts, with hex. nuts	30%	$3.90 net	.....

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York Current on Trucks	New York One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory
4x12x12	$0.11120	$0.1196	$0.0707	$0.095	$0.0635	$0.108	.....
6x12x12	.16670	.1345	.0973	.....	.08	.156	.....
8x12x12	.20840	.1794	.1326	.175	.12	.244	$0.17890

LUMBER—Prices of rough Douglas Fir No. 1 common, in carload lots to dealers, in yards at San Francisco. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$24.00	$24.00	$25.00	$30.00
3x6 and 8	25.00	25.00	26.00	31.00
4x4-6 and 8	25.00	26.00	27.00	32.00

LUMBER (continued)

Wholesale prices to dealers of long leaf yellow pine. To contractors in New York City, delivered from lighters or cars to job, $5 additional.

	New York 20 Ft. and Under	New York 22-24 Ft.	Chicago 20 Ft. and Under	Chicago 22-24 Ft.
3x4 to 8x8	$38.00	$39.00	$39.00	$41.00
3x10 to 10x10	41.00	42.00	42.00	44.00
3x12 to 12x12	44.00	45.00	45.00	47.00

Other Cities

	8 x 8-In. x 20 Ft. and Under Pine	Fir	Hemlock	Spruce	12 x 12-In. 20 Ft. and Under Pine	Fir
Boston	$50.00	$52.00	$55.00	$45.00	$54.00	$52.00
Cincinnati	39.00	50.00	.....	.....	40.00	64.00
Montreal	78.00	45.00	35.00	35.00	78.00	47.00
Denver	.....	35.75	35.75	35.75	.....	36.75
Minneapolis	43.00	40.00	39.00	.....	47.00	40.00
Kansas City	33.00	34.00	.....	.....	36.00	35.00
Birmingham	21.00	.....	.....	.....	26.00	.....

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.40@2.50	$3.15	$3.90	$5.00	$3.25	$4.95
Cut	2.25	5.80	5.90	7.75	....	5.00

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots *without bags*. Cash discount not deducted.

	Current	One Month Ago	One Year Ago
New York, del. by truck	$2.40@$2.50	$2.40	$2.80
Chicago, f.o.b.	1.97	1.97	2.17
Cleveland, f.o.b.	2.26	2.26	2.43

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	180-lb. net Common
New York	$15.80@$16.80	$12.50	$3.68	$2.75@$3.18
San Francisco	22.00	18.00	.....	1.75

LINSEED OIL—These prices are per gallon:

	New York Current	New York One Year Ago	Chicago Current	Chicago One Year Ago
Raw in barrel (5 bbl. lots)	$0.88	$0.80	$0.98	$0.75

WHITE AND RED LEAD—Base price in cents per pound:

	Red Current Dry	Red Current In Oil	Red 1 Year Ago Dry	Red 1 Year Ago In Oil	White Current Dry or In Oil	White Yr. Ago Dry or In Oil
100-lb. keg	12.50	14.00	13.00	14.50	12.50	13.00
25 and 50-lb. kegs	12.75	14.25	13.25	14.75	12.75	13.25

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in.	49½c per ft.

Air First Grade	Air Second Grade
¾-in. per ft. $0.24	$0.19½

Steam—Discounts from List

First grade ..... 40-10% Second grade ..... 50-5% **Third grade** 5-10-5%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition ..... 60–10–5% Best grade 60–5%

LEATHER BELTING—Present discounts from list in fair quantities:

Light Grade	Medium Grade	Heavy Grade
50%	40-5%	35%

RAWHIDE LACING—For cut, best grade, 50-10%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 39c. Semi-tanned: cut, 50%; sides, 43c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ½ in.	$0.90
Rubber sheet	.45
Rubber sheet, wire insertion	.70

MANILA ROPE—Per lb., ¾-in. and larger, 1,200-ft. coils.

Boston	$0.20	New Orleans	$0.17½
New York	.17	Los Angeles	.16½
Chicago	.19	Seattle	.18

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	7.50@10.00	12.00	12.00
Mixed	5.50@9.00	9.00	9.00

EXPLOSIVES—Prices per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.2950	$0.3250
Kansas City	.24	.2750
Denver	.2250	.2550
Baltimore	.2550	.27
Cincinnati	.2350	.255
New Orleans	.2725	.3075
San Francisco	.195	.23

FLOTATION OILS—All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.10
Pine oil, pure, dest. dist.	gal.	.95
Pine tar oil, ref., sp gr. 1.025-1.035	gal.	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.	.35

NEW MACHINERY AND INVENTIONS

The Parker Flotation Machine

Claims Made Include Small Repair Cost, and Minimum Operative Power and Attention

IN THE MILL of the Bunker Hill & Sullivan Mining & Concentrating Co. at Kellogg, Idaho, and also in the Alhambra mill, owned by the Bunker Hill & Sullivan, the Parker flotation machine is accomplishing remarkable results. The machine is the invention of J. B. Parker, flotation metallurgist for the Bunker Hill & Sullivan company. Mr. Parker also developed the successful flotation treatment for the complex ores of the Star mine, recently purchased by the Bunker Hill and Hecla companies. Prior to his present connection, Mr. Parker was with the Callahan Zinc-Lead Co., where he solved the problem of recovery of both zinc and lead by selective flotation.

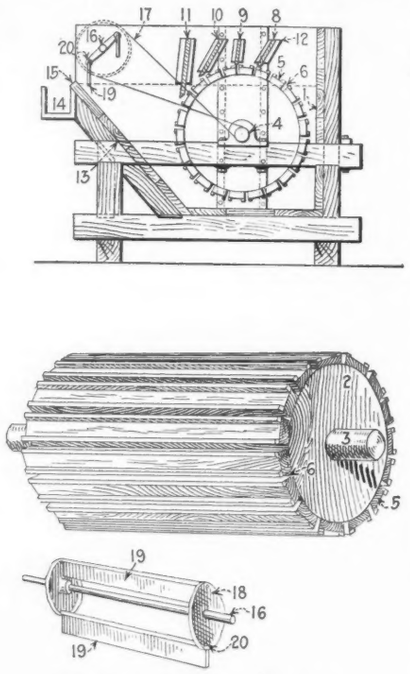
The Parker machine, for which patent is pending, is constructed of wood, driven by belt at a speed of 78 r.p.m., and requires 5 hp. for the standard 8-ft. machine, with pulp 35 per cent solids. The machine is especially adapted to selective flotation, and its low power consumption per ton, easy assemblage, and long wearing qualities make it a desirable unit for the small mill, and as it runs with the minimum attention (the only attention required is to oil once a shift), it should also be equally desirable for the large plant. The efficiency of the machine is amply shown in the following test, the results of which appear in the accompanying table. This test was run in the Bunker Hill & Sullivan concentrator. The feed was the combined classifier overflow and vanner tailing. The oil used was a mixture of 80 per cent Barrett No. 4 and 20 per cent steam-distilled pine. The only change made during the test was the per cent of solids in the feed. Samples were taken at regular intervals for eight hours.

RESULTS OF TEST OF PARKER FLOTATION MACHINE

Date 1921	Per Cent Solids	Recovery	Per Cent Lead in Concentrate	Per Cent Lead in Tailing
Nov. 24	36.0	82.6	57.9	1.38
25	31.0	83.0	66.7	1.54
26	31.0	83.1	64.5	1.50
27	31.0	87.5	64.1	1.10
28	33.0	88.3	58.7	1.00
29	31.0	89.0	58.0	1.00
30	38.5	81.9	55.6	1.60
Dec. 2	31.0	89.0	65.3	1.00
3	37.5	84.2	65.7	1.30
4	37.0	81.4	66.0	1.80
5	37.0	83.5	67.5	1.60
6	31.0	88.5	68.1	1.00
7	31.0	85.5	61.0	1.30
8	32.0	89.0	58.0	1.00
9	32.0	91.0	63.9	0.80
10	32.0	87.1	62.1	1.00
11	32.0	91.1	61.0	0.80

The work of the regular mill operators checks close with the results shown.

The body (1) is a rectangular-shaped box divided by an imaginary line into agitation and settling compartments. The rotor (2) revolves anti-clockwise at such speed that the greatest amount of pulp will cling to it. The pulp passes baffle boards (8 and 9) and will draw to itself an excess amount of air. The air not required for flotation is then expelled by baffles (10 and 11). After passing baffle 11, the pulp comes to rest in the settling compartment or spitzkasten, where flotation takes place. The froth in its travel from baffle (11) to lip (15) has opportunity to drop or release the entrained material which is to be rejected, and this material, after reaching the discharge end, is finally released by a weir, thus maintaining a constant pulp level in the machine. If conditions require froth to be removed



The Parker flotation machine

mechanically, a scraper or froth remover (18) has been provided.

The froth remover consists of a shaft (16) to which an arm (20) is keyed, and from this arm scrapers (19) are suspended. The froth remover travels clockwise and the edges of the scrapers remove a definite amount of froth each time. The speed is so regulated that the froth will have time to replace material removed before another cut is made. Launder (14) conveys froth to another machine or bin. The rotor (2) is constructed by keying to the shaft or tube (3) four spiders. Riffles (5) are bolted to the spiders, and consist of strips 2 x 4 in. x 8 ft., on the edge of which are tacked strips ½ x 1 in. x 8 ft. These strips can be easily replaced if necessary.

The installation in the Bunker Hill mill consists of eight machines in two banks of four each, operated in series. The feed is split, half going to each bank. The first three machines make a finished concentrate. The fourth concentrate is in a closed circuit with a Dorr thickener, and returns as feed, and the fourth machine makes a finished tailing to waste. The machines are so placed that the tailing of the first travels by gravity as feed for the second, and so on.

Material to be floated is deposited with the required air on the surface of the pulp, thereby necessitating less oil to float a given amount of sulphides. This fact is important in selective flotation, and especially so where the separation depends upon the amount of oil used. Good aëration, with a close regulation of the same, is obtained. The repair expense is small, due, first, to the slow speed and small exposure to wear, and, second, to the fact that all repairs can be made without removing the rotor. Operation of the machine requires the minimum amount of horsepower per ton of solids, and, because of simplicity, it demands the minimum attention per ton of solids.

INDUSTRIAL NOTES

The Bucyrus Co., of South Milwaukee, Wis., has extensive enlargements to its plants at both South Milwaukee, Wis., and Evansville, Ind., under way.

The American Smelting & Refining Co. has purchased a 7-ft. diameter x 36-in. cylinder Hardinge conical ball mill for regrinding in El Paso unit. The same company, through its New York office, has purchased another 7-ft. diameter x 36-in. cylinder Hardinge conical ball mill for one of its plants in South America.

C. A. Coffin has retired as chairman of the General Electric Co., and is succeeded by Owen D. Young, long associated with the company as vice-president. Gerard Swope, president of the International General Electric Co., succeeds E. W. Rice, Jr., as president of the company. The latter will now devote his entire energies to the further upbuilding of the scientific, engineering, and technical phases of the company's work in the broadest sense, and will be honorary chairman of the board of directors. Anson W. Burchard, for many years vice-president, with particular reference to public utilities and foreign investment, was elected vice-chairman of the board. J. R. Lovejoy, vice-president in charge of sales, was elected a director, as was also G. F. Morrison, vice-president.